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LIGHTING AND THE HYGIENE OF THE EYE*

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A few years ago, one of the past presidents of the Illuminating Engineering Society said in addressing that society: "Like crabs, producers and distributors of light have approached their objective backwards. They have spent millions of dollars in creating and distributing a commodity without ever seriously asking themselves what was needed by the consumer, the eye." In 1911, a committee composed of engineers and medical men convened in Philadelphia to consider the problem of lighting in relation to the eye. No more pertinent recommendation was discussed at that time than that we revert by imitation as nearly as possible to the illuminants of our fathers, the candle and the kerosene flame; that the intensities and color of illumination so obtained were best for the eye. At that time, a very popular reflector was the old Holophane clear ribbed glass product, designed to give evenness of distribution of light, but almost as trying to the eye as the naked lamp itself. Vague and contradictory opinions were held as to the importance or even the existence of other factors. Since then, great progress has been made in the science and art of lighting. The achievements of the various illuminating engineering societies comprising the contributions of interested groups of workers representing many walks of life, constitute an important chapter in the history of scientific, industrial and hygienic progress.

Confronting the subject of lighting in relation to the eye, the following problems are presented: (1) the determination of the factors in the lighting situation which are apt to affect the eye; (2) the selection of the eye functions which are the most apt to be affected, and (3) the devising of sensitive and reliable methods of measuring or testing these effects. Many studies of this kind have failed because the most important functions have not been selected for testing. Another cause of failure has been the lack of sensitive methods of making the tests. The purpose of a laboratory test in relation to a problem of this kind is to indicate or pick up in a short time of exposure to the conditions to be

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tested the effects which will be produced in a much larger measure under the longer periods of exposure to which the working eye is subjected. For this, great sensitivity is required. The analogue of the amplifier in physical measurements must be applied. In the early attempts at the solution of this problem, the acuity test alone was used. It failed because, as applied at that time, it did not have the sensitivity needed to pick up the small effects on the eye which occur in a short time of exposure. We remember well the challenge issued by a prominent ophthalmologist to a group of engineers and medical men at an early meeting for the consideration of this subject: "I defy any one to show by test a difference in the effect on the eye between a good and a bad lighting system."

During the past seventeen years a large number of factors has been tested in more than a hundred different representative lighting situations. In this connection two groups of factors may be noted: those pertaining to the light itself and those pertaining to the distribution in a lighting situation. To the former class belong the physical factors: wave length and composition of light, purity and intensity and their subjective aspects, hue, saturation and brightness; and to the latter, evenness of illumination, evenness of surface brightness, diffuseness of light and the angle at which the light falls on the work. The effect of these factors on seven functions selected with careful reference to their importance to the working eye has been tested by methods designed especially for the purpose. These functions are acuity or power to see clearly, speed of discrimination or speed of clear seeing, power to sustain acuity or the power to maintain clear seeing for a period of time, ocular fatigue, ocular discomfort, the near point and relative accommodation or power to separate the functions of accommodation and convergence—better stated perhaps as the power to maintain clear seeing under an abnormal relation of innervation for accommodation and convergence. The first four of these are important aspects of acuity but aspects not taken into account in the conventional method of testing acuity. Moreover, their addition to the acuity test has greatly increased its sensitivity. Differences in lighting conditions which produce little, if any, detectable effect on the power to see clearly as measured by the acuity test have been found, for example, to produce large effects on the speed of seeing and still greater effects in order on the power to sustain clear seeing and the tendency to produce ocular fatigue. Another notable fact with regard to these tests is the agreement which they have given with regard to the favorableness or unfavorableness of effect on the eye. The order of merit or ranking given to the factors and conditions studied by means of them has always been the same with one exception, the ranking given to the short as compared with the long wave lengths of light by the test for acuity and speed on the one hand and the tests for power to sustain and fatigue on the other. That is, the relative effect of

the short and long wave lengths of light on the eye's powers of performance seems to sustain a significant relation to the length of time the eye is exposed to the light. For long exposures, the shorter wave lengths seem to be relatively unfavorable. This point has been discussed in a former publication.[1]

Obviously, in the compass of this paper we cannot discuss the work that has been done in its concrete setting. The most we can hope to do is to give the results that have been obtained for the factors noted, indicate their relation to the concrete lighting situation, and explain as best we can from our knowledge of the eye and its functions why the effects obtained were produced. These factors will not be discussed in the order in which they were investigated, but rather from the standpoint of their simplicity and the primacy of their relation to the problem in hand. Like the manufacturers and merchandisers of light, we too have backed up to our problem; that is, we began with the more complex, concrete situations and are now just arriving at a consideration of the fundamentals and their synthesis into a system of practice and explanation.

THE FACTORS IN LIGHTING AND THEIR EFFECT ON THE EFFICIENCY OF THE EYE

Perhaps at this point in our discussion an analysis of the act of seeing would be helpful. Two groups of functions are involved: the resolving power of the refracting media or the power to form clear images on the retina, and the resolving power of the retina or the power to discriminate detail in the images formed. The resolving power of the retina may be further subdivided into three functions: the power to sense colorless light, brightness sensitivity; the power to sense colored light, color sensitivity, and the power to discriminate separateness of detail or what is commonly called space discrimination. The explanation of the serviceability of light and of its elaboration into a satisfactory system or plan of illumination is to be found in terms of the effect on these functions and their interactions, both momentary and through a period of time. For example, wave length, intensity, composition of light and purity affect the resolving power of the refracting media or the power to form clear images on the retina; intensity, brightness or luminosity, hue and saturation, the power to discriminate detail in the image formed or the resolving power of the retina; and evenness of illumination, evenness of surface brightness, diffuseness of light, and angle at which the light falls on the work, the interaction between these groups of functions.

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1. Ferree, C. E., and Rand, G.: The Effect of Variation of Visual Angle, Intensity and Composition of Light on Important Ocular Functions, Tr. Illum. Eng. Soc. **17**:69, 1922; Further Studies on the Effect of Light on Important Ocular Functions, ibid. **19**:424, 1924.

Wave Length.—Wave length of light affects the clearness of imaging through diffraction. Because of this phenomenon, faint rings of light form about each point in the image. These rings known as diffraction rings or circles, overlapping adjacent points, serve to blur the image. Their breadth varies directly as the wave length of light and inversely as the aperture of lens used, determined by the breadth of the pupil. From this it follows that clearness of imaging varies inversely as the wave length used and that the lens should have its highest resolving or focusing power for the short wave lengths. For example, it is well known that in microscopy the highest power to discriminate detail is given by the short wave lengths and that in photomicrography the sharpest images are formed on the photographic plate by these wave lengths. If, then, it is true that the eye sees most clearly when used in conjunction with the microscope under the short wave lengths, it might be inferred that an analogous result would be obtained when it sees its object by its own powers alone. This, however, has been found not to be true, at least for the seeing of black letters or other characters on the printed page illuminated by the wave lengths in question. The clearest seeing, also the greatest speed, power to sustain, etc., are given by the wave lengths in the midregion of the spectrum—the yellow, the orange-yellow and the greenish yellow. Moreover, this result is not surprising when we consider the difference in the factors involved in the two cases. The short wave lengths form the clearest images on the retina, but the wave lengths in the midregion of the spectrum give the retina its highest power to discriminate detail in these images. That is, in the visual field the image-forming function is involved only once, and the advantage of the short wave lengths due to the diffraction effect is more than compensated for by the greater advantage given to the retina by the wave lengths in the midregion of the spectrum. In vision with the microscope, however, the image-forming function is involved twice; that is, another refracting system has been added to the eye, and whatever affects this function favorably becomes of correspondingly greater relative importance in the total act of seeing.

The relation of wave length to lighting is obvious. None of the artificial illuminants are entirely colorless; all have dominant wave length or group of wave lengths. The so-called filamentless illuminants even approximate spectrum lights in their simplicity or purity. Unfortunately, however, these illuminants do not radiate exclusively or dominantly the wave lengths of the spectrum which have been found to give maximum acuity. Moreover, the hue of the illumination given is not the most favorable for the discrimination of the black letter on the printed page.

Purity.—Purity of light affects the clearness of imaging through chromatic aberration. Aberration circles form about each point in the

image due to the difference in the focal length of the lens for the different wave lengths. Clearness of imaging which depends on the number and breadth of these circles sustains a direct relation therefore to the number of wave lengths making up the light in question and their displacement from each other in the spectrum.

Composition.—The influence of composition of light is a combination of the effects of wave length and purity; the shorter the wave lengths and the greater the purity the clearer is the image formed. In drawing conclusions from this with regard to lighting, however, one must remember that clearness of imaging is only one of the functions involved in clearness of seeing. The retinal powers and what are favorable to them must always be taken into account. One might be tempted, for example, to conclude from what has just been said of purity and composition that lights of the greatest purity, namely, spectrum lights and the illuminants which most closely approximate them in simplicity, give uniformly greater clearness of seeing than mixed lights. This is not true. Spectrum lights do give greater clearness of seeing than mixed colored lights of the same hue, saturation and luminosity, but white light which is made up of all the wave lengths of the spectrum mixed in what is called a balanced or neutral proportion for the eye gives a better power to discriminate detail on the printed page than any colored light of equal luminosity even though of spectrum purity. As will be seen later, this is due to the fact that color forms an unfavorable background against which to discriminate details in black which more than balances the disadvantage of the slightly blurred image due to the mixed character of the white light.

Hue of Color.—The effect of color on the power of discrimination should be discussed in relation to the type of detail that is to be discriminated. If the detail is a black letter or other printed character, hue of light determines the quality of background from which it must be distinguished. Some hues are apparently more favorable than others as a background for the discrimination of details in black. All hues are inferior to white in this regard. Repeated tests have shown that white is the best background on which to discriminate details in black.

The question is frequently raised as to which is the more favorable relation of object to background—white on black or black on white. In this connection our results on speed of vision have shown that near the threshold of acuity, i.e., for small visual angles and low intensities of illumination, speed of discrimination is higher for such objects as a black letter on white (detail to be discriminated white) than for a white letter on black (detail to be discriminated black). At this level of seeing, space discrimination is probably the most important factor in the speed of discrimination of detail. Because of irradiation in the image formed on the retina, the detail to be discriminated in case of the black letter on

white is larger than that to be discriminated in case of the white letter on black. With larger objects, however, and higher intensities of illumination the speed of discrimination is higher for the white object on black than for the black object on white. In these cases the difference in sensation between object and background, which is greater for the same difference in coefficient of reflection in case of the white object on black than the black object on white, is the dominating factor.

Saturation.—Saturation may be defined as the proportion of the chromatic or colored to the achromatic or colorless component of the sensation aroused by the light. As the saturation is increased for any hue its inferiority in relation to white as a background on which to discriminate details in black is increased. The colors in the midregion of the spectrum owe their superiority to other colors in this regard in part to their hue and in part to their low saturation. This point has been determined through a large number of tests on spectrum lights selected at eight significant points in the spectrum; mixed colored lights, spectrophotometered to give their composition; and the artificial illuminants: kerosene, gas and electric, including the various types of carbon and tungsten lamps and six Welsbach mantles differently colored by varying the proportion of ceria and thoria. In some cases the tests were made with the lights equalized in luminosity alone, in others, when equalized both in saturation and in luminosity. The equalization in luminosity alone was made to duplicate the conditions in a lighting situation; the equalization in both saturation and luminosity to determine whether both saturation and hue must be taken into account in listing the factors which affect the powers of the eye.

Intensity.—Intensity as a factor should be discussed in relation to kind of light. In case of white light the effect of increase of intensity is to increase its luminosity or brightness. This increase of luminosity gives a greater power for clear seeing independent of sharpness of imaging through its influence on the retina's power to discriminate detail in the image. Also with a given difference in coefficient of reflection between an object and its background, the sensation difference is increased by increase of intensity of light. Because of this phenomenon the object is, of course, more readily discriminated from its background under high than under low intensities of light. Strange as it may seem, this increase in sensation difference is greater in case of white on black or light objects on a dark background than it is in case of black on white or dark objects on a light background. A greater effect of increase of intensity of light on visibility may be expected, therefore, in the former than in the latter case.

There is an effect of increase of intensity of light also on the sharpness of the image formed by the refracting system due to the contraction of the pupil. That is, the narrowing of the pupil excludes the

aberration effects and other irregularities resulting from the use of the periphery of the lens and cornea and by narrowing the cone of light from each point in the object reduces the size of the diffusion circles formed by faulty focusing.

The following points may be noted with regard to increase of intensity: 1. The benefit is greater when the work or details to be discriminated are small than when they are large; also when the difference in coefficient of reflection between the object and background is small than when it is large. The larger the work and the greater the difference in coefficient of reflection from the background, therefore, the less is the need for high intensities of illumination and the smaller is the range over which an increase of intensity may be expected to give a high return. That is, the point at which increase of intensity ceases to give its larger effects shifts rapidly toward the lower end of the scale as the value of either size of object or difference in coefficient of reflection is increased. Under all the conditions investigated, however, the benefit of increase of intensity is still present to a considerable degree at 100 foot candles. 2. The benefit of increase of intensity is greater for light objects on dark backgrounds than for dark objects on light backgrounds. The range of intensities over which the larger effects are obtained is greater also for the former than for the latter case. 3. It is greater for an eye that is defective in refraction than for a normal eye. 4. It is greater for the old than for the young eye.

These effects are not difficult to understand. (*a*) The larger the image formed and the greater the brightness and sensation difference from its background, the less need has the retina for high intensities of light to enable it to discriminate detail and the less it benefits by increase of intensity of light; conversely, the smaller the image and the smaller the brightness and sensation difference from the background, the greater is the need for high intensities and the greater the benefit from increase of intensity. (*b*) With a given difference in coefficient of reflection between object and background the sensation difference increases more rapidly with increase of intensity of illumination for a light object on a dark background than for a dark object on a light background. As might be expected, therefore, a greater benefit of increase of intensity of illumination is obtained in the former than in the latter case. (*c*) There is more need for a high intensity of illumination in case of a blurred than of a clear image, and more benefit is obtained from an increase of intensity of light. Not only has this been shown repeatedly by test but it is a matter of common ophthalmic experience to find that an eye which is apparently well enough corrected for medium and high intensities of light is not sufficiently well corrected for low intensities. Small defects and blurrings of the image that give no trouble at high illumination may give a great deal of trouble at low illumination. Unless

there is some accompanying photophobia, there is a general demand among wearers of glasses for more light. Particularly do they find a low speed in the use of the eye at low illuminations and a diminished power to sustain clear seeing through a period of work. (*d*) Among the reasons why an old eye needs more light and should derive more benefit from an increase in the amount of light, the following four may be mentioned: the inferior imaging power of its refracting media; the diminished transparency of the media; the decay in all of its processes of adaptation and adjustment, and the failing powers of the retina itself. Of especial importance to the old eye is the effect of increase of intensity of light on the near point and on relative accommodation or the power to separate accommodation from convergence; that is, with increase of intensity of light the old eye has less difficulty in seeing near objects, and there is a greater range over which clear seeing is possible when accommodation and convergence are not functioning in their accustomed relations. The latter effect also is an important benefit of increase of intensity of illumination to eyes suffering from error of refraction; for example, myopic and hyperopic eyes are required to maintain clear seeing under an abnormal relation of innervation for accommodation and convergence. The strain of doing this is much reduced by increase of intensity of illumination. It may not be out of place to note here also the danger of the prolonged mydriasis attendant on low illumination to old eyes suffering a predisposition toward glaucoma; likewise, the similar danger to this type of eye from the inflammatory conditions which may be set up by the strain resulting from working or reading under an inadequate amount of light. In determining the amount of light needed for different people and for different conditions of working, all of these facts should be taken into account. And especially in case of all eyes should it be noted that the effect of intensity of light on the speed of seeing and power to sustain clear seeing through a period of work is much greater than on acuity itself. The eye sees its object much more quickly, sustains its powers of clear seeing much better, becomes fatigued less quickly and suffers less discomfort under daylight intensities than under those found in artificial lighting by present practice. These facts have an important bearing on industrial lighting, particularly in those industries in which a high grade of performance is required of the eye. In such industries an increase of intensity of light should result in an increase in the ease and speed with which the employees do their work and a better power to sustain a given level of performance throughout the working period, provided that the increase of intensity is secured under the proper conditions of distribution. The latter, however, is an important qualification to add. If the increase of the intensity of the illumination is to be accomplished by a proportionate increase in the number and brilliancy of bright sources

of light in the field of view or by an increase of glare on the working surface, the attempt will result in harm, not good. Fourteen years ago, we would not have considered it safe to speak in favor of increased intensities.[2] Now, owing to the great advancement that has been made in ways and means of delivering the light safely and effectively to the eye, we consider it not only safe but strongly advisable. The large difference in intensity between a room well lighted by daylight (from 10 to 20 foot candles) and a room lighted by artificial light according to present standards of practice (5 foot candles and more often less) is in our opinion no small factor in the difference in the eye's well-being and vigor and efficiency of performance in the two cases. The room well lighted by daylight gives the best results for the eye that have as yet been obtained, and we will not go far wrong in taking it as our pattern for artificial lighting with regard to intensity as well as for color and composition of light and the factors which come under the head of distribution.

In this connection, too, it may not be out of place to note the mentally stimulating effect of high intensities of illumination. Every one is familiar with the somnolent effect of low and the wakeful influence of high illumination. Many persons are not able to sleep in the full light of day. Personally, one of us is a poor night worker. He was astonished at the curative effect on this annoying disposition produced by more than doubling the intensity of illumination under which the work was done. Two reasons may be noted for the benefit, the relief from eye strain produced by the higher intensity of light and its generally stimulating mentally awakening, conscious-heightening influence. Again, however, caution must be urged against the increase of intensity through the introduction of high brilliancies into the field of view or glare on the working surface. If these are involved, a premature drowsiness and loss of mental alertness through fatigue of the eye are induced rather than warded off by the increase of intensity.

For colored light the effect of increase of intensity is not so simple. There is a similar increase in the power of discrimination with increase of intensity through increase of luminosity, but the benefit produced by the increase in luminosity is complicated by the effect of changes in saturation and hue. These changes may become more or less favorable as the intensity is changed and add to or subtract from the power of clear seeing correspondingly. The effect of increase of intensity of light on the color sensation may be described as follows: There is an increase of luminosity which is more or less regular over small ranges

2. Ferree and Rand: The Efficiency of the Eye Under Different Conditions of Lighting: the Effect of Varying the Distribution Factors and Intensity, Tr. Illum. Eng. Soc., **10**:407, 1915.

of the intensity scale. Saturation increases to a maximum and then decreases to zero or to a very low minimum. The point of maximum saturation is reached at a comparatively low intensity, much lower, fortunately, than any intensity that is used for illumination purposes, and the change throughout is less regular than the change in luminosity. Up to the point of maximum saturation then, saturation change works against clear seeing; beyond this point the change is favorable to clear seeing. Hue is affected in a very complicated and irregular way by changes of intensity. A few of the changes in hue for spectrum lights may be mentioned. All of the wave lengths from red to yellow pass through yellow to white with increase of intensity beyond the point of maximum saturation. Green also passes through yellow to white with increase of intensity. All of these changes are favorable to clear seeing. At low intensities, red becomes brownish and yellow, greenish; orange is tinged with greenish brown and blue with purple. At low intensities, green is seen as blue or blue-green. These changes are in part favorable and in part unfavorable for clear seeing. In case of mixed colored light the effect of change of intensity on hue is greater in amount and not always the same in kind. This might well be expected because the effect of change of intensity is not only on the sensations aroused by the component wave lengths but on the physiologic interactions caused by combining these wave lengths. This threefold effect of intensity of light on the color sensation; namely, changes in hue, saturation and luminosity, must be taken into account not only in matters pertaining to clear seeing, but also in all colorimetric work. A hue and saturation specification of a color for one intensity of illumination is, strictly speaking, valid for that intensity alone.

The explanation of the effect of intensity, luminosity, hue and saturation on the power of the retina to discriminate detail is given, it will be noted, in its simplest and most direct terms, that is, in terms of the qualitative differences in the sensations aroused by the images on the retina. Details subtending the same visual angle at the eye which present the greatest differences in sensation from each other or from the background are the most easily distinguished from each other and from the background. This is so clearly self-evident that even to state it seems tautologic; that is, our only method of detecting qualitative differences in sensation is based on ease of discrimination. It may be that later some other way will be found for explaining the effect of these factors on the retina's power of discrimination, but at present the data are, so far as we know, not available on which to base a different explanation. It may be too that wave length has some influence on the resolving power of the retina other than through the quality of sensation aroused, but as yet such considerations can be regarded as only speculative.

While we have considered it intrinsically important to determine whether saturation and hue are both factors in power of discrimination, a special incentive was furnished by the needs of the paper manufacturers. The investigations of color in relation to acuity, speed and power to sustain, the most important aspects of seeing, were begun because of a request made by the American Writing Paper Company who wished to obtain a specification of the ideal printed page. It is important for the paper manufacturers as well as for the lighting profession to know whether one, two or all of the aspects: brightness, saturation and hue are to be taken into account in presenting the most favorable conditions for clear seeing.

As the result of our investigations we can affirm confidently that all colors of the same saturation and brightness do not give equal powers of seeing. The hues in the midregion of the spectrum are the most favorable for the coloring or the illumination of the reading page. Ranked as to order of merit from best to worst they are: yellow, orange-yellow, greenish-yellow, orange, green, red, blue-green and blue; but all coloring is inferior to white if the printed characters are to be black.

More important, however, than any of the factors pertaining to the light itself with the exception of intensity of light are the distribution factors—evenness of illumination, evenness of surface brightness, diffuseness of light and the angle at which the light falls on the work.

Evenness of Illumination.—The desirability of evenness of illumination is too obvious to need much comment; that is, unevenness of illumination is not only poor economy of distribution, but when the differences are large in conjunction with differences in surface reflecting power, they introduce glaring contrasts and harmful brilliancies into the field of view. Unevenness of illumination of the reading page or other working surface leads to fatigue of the eye by causing it to see its objects unequally well as it travels over the page, which tends to induce changes in adjustment to rectify the deficiency. With the exception of changes in the size of the pupil, these changes are maladjustments that work against rather than for clear seeing and tend to fatigue the eye. These ill suited changes which take place automatically when the eye is trying to clear up its vision as the result of the conditions imposed by bad lighting will be discussed later.

Diffuseness of Light.—Diffuseness of light and the angle at which the light falls on the work are important as contributive factors in relation to the disturbance which is commonly called glare on the working surface. The other important contributive factor is the way in which that surface reflects the light that falls on it. Surface reflections are of two kinds: specular and diffuse. Specular reflection occurs from surfaces that are polished or glazed; diffuse reflection from surfaces

that are mat or rough. The relation of specular and diffuse reflection to the problem in hand may be summarized as follows: 1. Diffuse reflection alone is serviceable to vision. The eye sees its objects in the working plane only by light diffusely reflected from that plane. The light specularly reflected either is entirely wasted, not entering the eye at all, or, worse than that, is directly harmful to vision. Which of these two results is obtained depends on relation of the angle at which the surface receives the light and the angle at which it is viewed by the eye. When the differences between these two angles is great, the former result is obtained; when it is not so great, the latter, and in inverse relation to the magnitude of the difference. 2. The light diffusely reflected from the surface spreads from each point as it would were the surface itself a source of light, and, when focused, forms an image of the surface. With light specularly reflected, however, this is not the case. Only the direction of the beam as a whole is changed; the angle of spread or divergence of the component rays is not affected. When a beam of light so reflected is focused, an image is formed of the source, not of the reflecting surface. When viewing a surface from which both kinds of reflection occur, the eye focuses, therefore, for the diffuse, not the specular reflection. The result is an image of the surface overlaid and blurred by a partially focused image of the source. 3. The disturbing effect of specular reflection reaches its maximum when the surface is illuminated by a direct beam of light, and is viewed by the eye at the same or approximately the same angle as that at which the light falls on the surface. It is comparatively slight when this surface is illuminated by diffuse light, and is, moreover, independent of the angle at which the surface is viewed.

From these considerations the relation of the harmful effect of specular reflection or glare to type of lighting system is obvious. If the light which falls on the surface is well diffused by one or more previous reflections and is evenly distributed, the confusion of vision from glare is slight. However, if it is received directly from the source, concentrated, and perhaps wrongly directed by a reflector, the effect is trying. A common cause of specular reflection from the working surface is the glazing or sizing of paper. One of the important specifications of the ideal printed page is the amount of glaze allowable. Obviously this depends to a large extent on the type of lighting employed. A great deal of glaze may be permitted when the illumination is received from totally indirect and dense semi-indirect reflectors or from direct reflectors provided with a means for diffusing the lights. A much smaller amount becomes intolerable when used under the nondiffusing types of direct lighting units.

Evenness of Surface Brightness.—The most important hygienic factor, however, in artificial lighting as it is practiced at the present time,

is evenness of surface brightness or its converse, high brilliancies in the field of view. Color and composition of light, evenness of illumination, etc., have been handled pretty satisfactorily so far as the general run of eyes is concerned, and higher intensities can be produced without a great deal of difficulty. The commercially most important method of changing the color and composition of light, however, has been to raise the temperature of the radiating body used as source. Witness, for example, the color of light from the low temperature carbon lamp as compared with the high temperature, Mazda C, gas-filled lamp. These higher operating temperatures have increased enormously the surface brightness of the luminous filament and have rendered the need for protecting the eye from harmful brilliancies increasingly important. Among the detrimental effects of high brilliancies in the field of view the following may be noted:

1. The brilliant image falling on a part of the retina highly sensitized because of its accustomed exposure to low illumination causes a sharp contraction of the pupil. A reduction of the pupil breadth by one-half means a cut-down of 75 per cent in the amount of light entering the eye from the working surface. This in case of artificial lighting, when the eye is already receiving too little light from the working surface, reduces enormously the ease, speed and power to sustain clear seeing of the details of that surface. That is, the effective light from a surface receiving 5 foot candles would be cut down to 1.25 foot candles by this reduction in the size of the pupil, and a surface receiving 3 foot candles to 0.75 foot candle. This we scarcely need point out has its effect on lighting bills as well as ophthalmic bills. Some idea of the magnitude of these exposures may be obtained from the following figures. In some of the lighting systems tested by us of a type now in common use, the highest brightness in the field of view, namely the luminaire itself, ranged from 600,000 to 800,000 times that of the working surface when both were compared or photometered in central vision. Had the brightnesses been compared as the surfaces were actually seen in the lighting situation—the working surface by the central portion of the retina and the luminaire by the more highly sensitized periphery—the difference would have been still greater. The harmful effects of these surfaces in the field of view increase, of course, with the number. And not only does the influence of this factor cut down the light received from the working surface, but it greatly reduces the power to see details in that surface from other causes to be noted later. Obviously, the surface which should control the pupil's reaction to light if that reaction is to be of service to clear seeing is the working surface itself, not the source of light. These abnormal contractions of the pupil induced by brilliancies many thousand times greater than are ever found on any working surface are also extremely uncomfortable and irritating to the sensitive iris. They doubtless lead to unhealthy

congestions in the network of blood vessels on the front and back surfaces of the ciliary body and the train of evils which may result therefrom, and to inflammations and congestions in other parts of the eye. I need scarcely point out that hyperemia of the conjunctiva soon takes place as the result of such an exposure due to this or some other harmful reaction within the eye. It is not altogether improbable, too, that a contraction of the pupil so largely in excess of the normal amount puts a strain on the muscles of accommodation because of the automatic tendency of the pupil reaction and accommodation to take place together in a more or less fixed relation.

2. The presence of a bright source of light or other surface of high brilliancy in the field of view produces a blinding effect through a phenomenon known as irradiation; that is, the source seems to be surrounded by a broad and intense halo of light, the intensity of which falls off as the source is receded from. This serves to confuse and blur seeing in direct relation to the intensity of the source and in inverse relation to its distance from the line of sight and the brightness of the remainder of the field of vision. Two causes of this phenomenon may be noted: the scattering of light by the refracting media of the eye which serves to throw an overlay of unfocused light on the image of the working surface; and an induction or spreading of the excitation on the retina produces a similar overlay in sensation. The effect of both of these factors on the clear seeing of details in black on a white surface is similar to that produced by laying a coat of white paint over a white surface on which black letters or other characters are represented. The white or luminous overlay affects the black more than the white, and the power to discriminate the black letters from the background grows less with an increase in the density of the overlay.

3. The presence of high brilliancies in the field of view produces disturbances in the control of the mechanism of the adjustment of the eye which rapidly lead to the fatiguing of the muscles of adjustment, and the loss of power to sustain the precision of adjustment needed for clear seeing. The most favorable condition of illumination for maintaining easy and comfortable fixation and convergence through a period of time, compatible with other conditions of clear seeing, is to have the field of view uniformly illuminated with diffuse light with no extremes of surface brilliancy. The illumination of the retina then falls off more or less uniformly from center to periphery and the brightest image formed is that of the working surface. The image of the working surface then controls reflexly the adjustments needed for seeing details in that surface without opposition from brighter images. On the contrary, the presence of high brilliancies in the field of view produces a strong incentive for the eyes to fixate and accommodate for them, which incentive must be controlled by voluntary effort. The result of this opposition of voluntary control against strong reflex incentive is to tire the eye quickly and

to make it lose the power to sustain the precision of adjustment needed for clear seeing of the work.

4. Brilliancies, if too high, may cause an actual damage to the retina itself. These may take the form of congestions and inflammations, scotoma, detachments, etc.

OCULAR DISCOMFORT AND OTHER SPECIAL POINTS OF INVESTIGATION

An important aspect in our experience with lighting from improperly shielded sources is the ocular discomfort produced. While it may require the help of tests to call attention to the bad effects of such lighting on the visual efficiency of the eye, every one is keenly aware of the discomfort produced. As we have already indicated, this feature has not been ignored in our study. In addition to making the test for ocular discomfort in connection with every lighting situation investigated, a special study has been made to determine in which parts of the field of view exposure to a high brilliancy exerts the greatest tendency to cause discomfort. This study was made by means of a large perimeter designed especially for the purpose, and the investigation was conducted in 16 meridians from the center to the periphery of the field. Details cannot be given here of the comparative sensitiveness to discomfort at different points in the field. It will be sufficient to say that the sensitivity for certain parts or zones in the peripheral field is greater than that for the center; that the sensitivity is in general greater for the temporal than for the nasal half of the field and for the lower than for the upper half, and that in passing from the center to the periphery the sensitivity is found first to increase then to decrease, becoming extremely little at the limits of the field. In the horizontal meridian on both the temporal and nasal sides, maximal sensitivity is found around the 45 degree point. In the vertical meridian, maximal sensitivity seems to be near the point 15 degrees below the horizontal. Footlights, so far as their position is concerned, are the worst lights that have been devised by the misdirected ingenuity of man to confound and torture the eye. Next perhaps in this regard are the lights in the motion picture studio and a close third are bright lights dropped from the ceiling of the ordinary living and reading room.

Other special points of investigation have been the determination of the possibility of shielding the eye satisfactorily and effectively from the ill effects of high brilliances in the field of view by means of eye shades and the best type of shade to use; also determination of the effect of motion pictures on the eye. Space cannot be taken here to discuss the results of these investigations. The results of both have been published.[3]

3. Ferree and Rand: Further Experiments on the Efficiency of the Eye Under Different Conditions of Lighting, Tr. Illum. Eng. Soc. **10**:448, 1915.

EYE STRAIN

In the attempt to understand the effects of bad lighting on the eye, one of the most fundamental principles to keep in mind is that the eye is always under a reflex incentive to clear up its vision. This incentive is strong, so strong that it is extremely difficult to oppose it successfully by an act of will or voluntarily to force the eye to make an adjustment detrimental to clear seeing. The eye has grown up under daylight. Under this condition only three adjustments have developed, and indeed only three are needed: the reaction of the pupil to regulate the amount of light entering the eye and to aid the lens in focusing the light from objects at different distances, and accommodation and convergence to bring the object on the principal axis of the lens and the image on the fovea, conditions necessary for the formation of the clearest images by the lens and for the best discrimination of these images by the retina. These adjustments take place under a sort of triple bond imposed by their common nerve supply, so strong that if one takes place the others also take place unless the power of separating them has been acquired, and even then their separation is accomplished only by great effort or strain. Artificial lighting with its unnatural and unfavorable conditions for clear seeing has come late in the history of the race, and the eye has not developed any reactions or adjustments to meet the conditions imposed. Yet the incentive to clear up seeing remains and leads to adjustments which, if allowed to take place, serve only further to blur rather than to clear up vision. For example, a change in accommodation which is a change designed to clear up an image blurred by changing the distance of the object is in no sense helpful, only harmful for clearing up an image blurred by bad conditions of lighting; yet so long as unclear seeing is present, due either to a blurring of the image or to unfavorable conditions for its clear discrimnation by the retina, the eye will strive by the three adjustments at its command to remedy the deficiency. *This striving to clear up its vision by ineffectual maladjustments is the cause of what is commonly called eye strain.* The misdirected effort or strain is of no service to vision and leads rapidly to fatigue and exhaustion, to deformities slight in their physical magnitude but great in their functional importance, to inflammations and congestions and to hypertensions and other conditions not found in a healthy eye. If the eye could only be educated to lie down under the bad conditions of seeing for which it has no specific corrective adjustment, the cause of vision would be just as well or even better served, and the eye itself would be a great deal better off.

BAD LIGHTING AS A CAUSE OF OCULAR DEFECTS

Perhaps it would help further in understanding these principles to apply them to the explanation of the production of an ocular defect to

which bad lighting is a frequent contributory cause, namely, myopia. There is little doubt that the greater number of cases of myopia are caused by an elongation of the eyeball. Normally, the eyeball is short at birth. In the act of convergence pressure is exerted on it by the muscles of convergence and their antagonists. Under the cumulative effects of this pressure it tends to yield along that dimension in which there is the least external resistance, namely, its anterioposterior diameter. If the coats are too weak or perhaps the external resistance offered by the fatty cushion and other structures at the back of the eye is unusually small, the eye elongates more than the normal amount to correct for its congenital hyperopia and becomes myopic. Poor lighting or any condition that renders vision unclear tends to increase this process of elongation with near work, for the following reasons:

1. Unclearness of seeing results in the work being brought closer to the eye in order that larger images be formed on the retina. This necessitates more convergence than is used for the normal working distance, and by adding to the pressure on the eyeball and perhaps increasing the pull of the optic nerve near the posterior pole of the eye tends to increase the process of elongation.

2. Any unclearness of seeing will result in an accommodative effort to clear up the image with its attendant influence on convergence and pupil reaction. Accommodation is an adjustment for unclear imaging due to change of distance, not bad lighting, and its exercise to clear up faulty vision due to bad lighting makes the situation worse rather than better. This accommodation strain leads to hyperemia or congestion of the network of blood vessels just in front and behind the ciliary muscles. The congestion in this so-called danger zone of the eye leads in turn to an increased flow of fluid into the anterior chamber from the blood vessels on the anterior border of the ciliary muscles and into the vitreous chamber from those on the posterior border of these muscles, perhaps also through the products of the congestion or inflammation to a blocking up of the drainage angle between the iris and the base of the cornea. This disturbance in the normal balance of income and outgo of fluids into the interior of the eye results in a slowly developing hypertension which may be relieved, if the coats are weak, by a yielding along the anterioposterior diameter or by an elongation of the eyeball, and if the coats are strong, the hypertension results in a damaging pressure on the delicate structures of the retina and nerve-head or a slowly developing glaucoma.

It is somewhat difficult to trace all of the effects of eye strain. It is not a normal exercise of the powers of the eye, in either kind or amount, and no possible benefit can accrue from it. Rather it leads to an unhealthy condition of the eye, exaggerating and aggravating any abnormal tendencies or predispositions already present, lowering its

normal recuperative and restorative powers and leading sympathetically to functional disturbances in other parts of the body. Like any other organ of the body, if the eye is to remain healthy or to cure itself of any of its ills, congenital or acquired, it must first be put into a situation calling only for the healthy exercise of its normal functions.

AN OPHTHALMIC SURVEY AND SERVICE TESTS

It is a matter of great interest and curiosity to a laboratory worker when studying a problem of this kind to know how truthfully prophetic the results of his test for short exposure are or what would happen during the weeks and months and even years of experience of the working life. We are particularly fortunate in having a direct check of this kind on the implications of some of our results in the form of the ophthalmic survey of the employees of the New York City postoffices made by the Office of Industrial Hygiene of the United States Public Health Service.[4] This survey was made on 4,786 employees working in the General Postoffice and in the old City Hall Postoffice. Among the results obtained, the following may be noted: 1. An increase of intensity of illumination produced an increase in the speed of work. In mail sorting, this increase amounted on an average to 4.4 per cent for an increase of from 3.6 to 8 foot candles of light on the working plane. The saving to the postoffice in salaries due to this increase in speed of work was estimated to amount to $148,000 per year, a net gain of $109,000 over the cost of the increased intensity of illumination. 2. Employees having normal or nearly normal eyes worked most rapidly and with less fatigue under an intensity of artificial illumination of between 8 and 10 foot candles with the types of unit and installation used. Those with defects of the eyes in particular showed less fatigue when working under high than when working under low intensities of illumination. 3. The number of defects was found to sustain a direct relation to the amount of strain put on the eye by the work in question and an inverse relation to the intensity of illumination under which the employees had been accustomed to work. In the latter respect, it was found that the employees of the old postoffice, the majority of whom were working under an average illumination of from 2 to 3 foot candles had poorer vision and a greater number of certain defects than the employees of the new postoffice the majority of whom were working under from 3 to 4 foot candles. For those who had worked for some time under the lower illumination, a greater percentage of the following disturbances was found: low acuity for eyes both normal and defective

4. Lighting of Post Offices. Summary of a Report Made by the Office of Industrial Hygiene of United States Public Health Service at the request of Postmaster General Hubert Work, 1922, Government Printing Office, Washington, D. C., 1923.

as to refraction; errors of refraction, particularly myopia and astigmatism; inflammatory conditions; asthenopia, and muscle imbalance. The difference was especially large for refractive errors, inflammatory conditions, asthenopia and muscle imbalance. For inflammatory conditions the ratio was nearly 2:1; for asthenopia nearly 3:1. 4. Color as a background on which to discriminate details in black is of frequent occurrence in the work of the postal employees. Examples of this are found in addresses on colored envelopes, especially those from Central Europe, the markings on foreign and domestic stamps, red and blue cards and blanks in the money order and registry departments, etc. Black on blue is noted as being particularly trying, also brown on buff, red on a different hue and saturation of red, and all cases in which the character to be discriminated represents a small amount of sensation difference from the background from which it must be discriminated. In all cases, too, it is reported that the task is rendered still more difficult by the glossing or glazing of the surface on which the characters are represented.

This survey was made entirely independent of our work and was made several years after the greater part of it was finished; the conclusions were drawn, so far as we know, without any reference to or bias by our results. In all of the features covered by both investigations, the one of the laboratory, the other of service type, the agreement on all of the essential points involved is complete and rather striking.

APPENDIX

In figure 1 is shown a diagrammatic sketch of the visual pathway. From the anterior corpus quadrigeminum shown in the sketch, nerve fibers pass from the optic nerve to the Edinger-Westphal nucleus of the oculomotor nerve. A reflex arc is thus established between the retina and the muscles which govern accommodation, convergence and size of pupil. It is because of this reflex arc that changes take place in accommodation, convergence and pupil size to clear up blurred images on the retina. These adjustments are designed to clear up blurring in the image due to changes in the distance of the object. They are incited, however, by unclear imaging due to bad lighting and other faulty conditions of seeing, in which case they serve merely as maladjustments which harm rather than benefit vision, and lead rapidly to fatigue and exhaustion and to other conditions not found in the healthy eye.

In figure 2 is shown the eye in its normal position in the orbit. Its liability to distortion by muscle pressure and sustained convergence for near work can readily be seen. An elongation of the ball of the eye produces one type of myopia, the dangerous type; a distortion of the cornea, an astigmatism. A great deal of evidence may be cited in support of the belief that the muscle situation sustains a casual relation to both of these defects.

The movements of the eye are produced by four straight and two oblique muscles. The convergent movement, considered from its beginning in what is called the parallel position to its end when the eye has made its maximum excursion inward, is a complicated function of three of the straight muscles, the internal, superior and inferior recti. The oblique muscles, superior and inferior, steady the eye during the

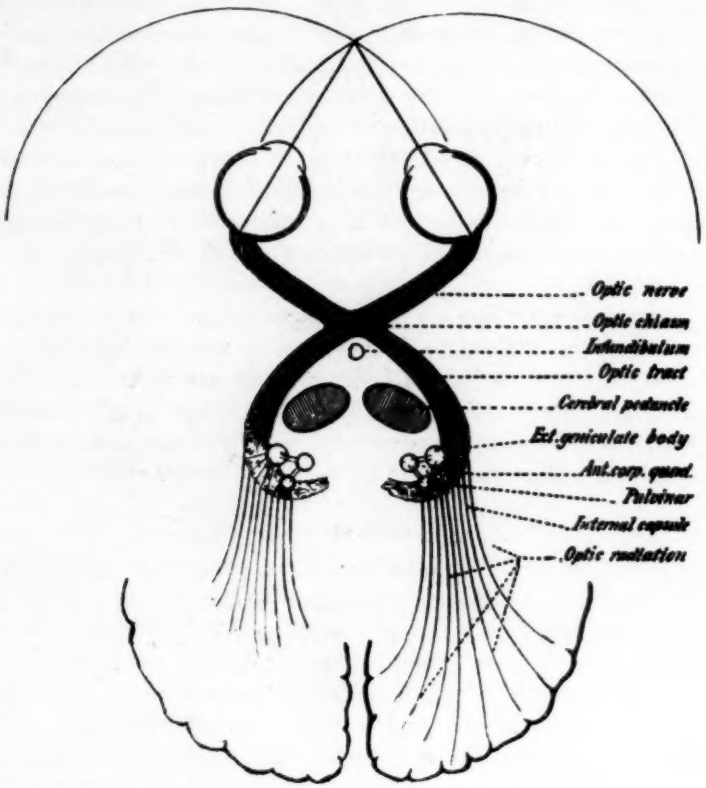

Fig. 1.—Diagrammatic sketch of the visual pathway. (Peter, Luther C.: The Principles and Practice of Perimetry, Philadelphia, Lea & Febiger.)

excursion and perhaps also aid the adduction in the more extreme positions of convergence. The diverging movement is also a complicated function of more than one muscle, the complication varying with the degree of abduction. The straight muscles are attached by a broad insertion well in front of the center of rotation and pass around the curved surface of the eye toward their point of attachment at the back and upper part of the socket or orbit. In contracting, the converging muscles turn the front of the eye inward and press the eye against the

external rectus muscle over a considerable portion of its length. The effect of the action of both sets of muscles, converging and diverging, is to exert a backward pressure on the contents of the eye toward the posterior pole. Furthermore, the two oblique muscles pass around the eye from their insertion at a point at the back toward the front of the orbit in such a way as to give to some extent the effect of suspending the posterior half of the eye in a noose, which in tightening, by the con-

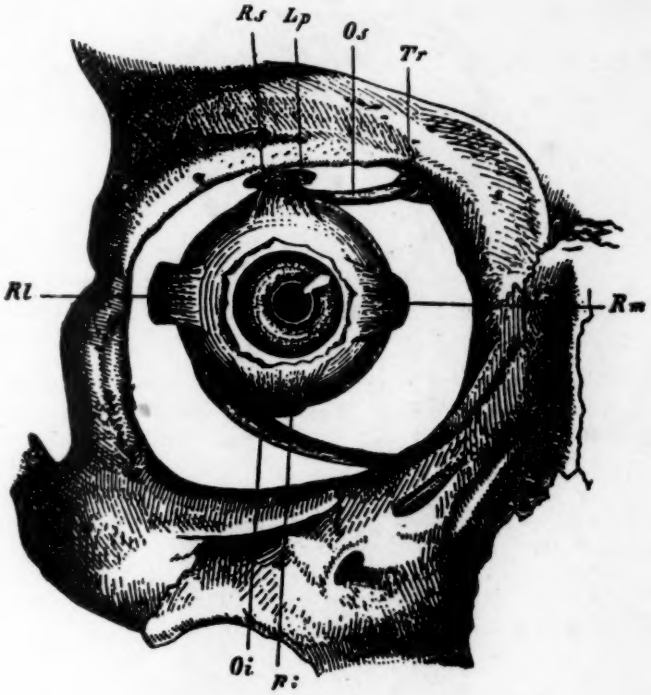

Fig. 2.—The eye in its normal position in the orbit. (Howe, Lucien: The Muscles of the Eye, vol. 1, New York, G. P. Putnam's Sons.)

traction of one or both of the muscles, opposes the backward pressure of the straight muscles. The point of attachment, however, and the course of the oblique muscles is such as to leave a segment of the back wall of the eye without external reenforcement. The front of the eye is reenforced by the pressure of the four straight muscles which are attached, as already indicated, on a broad base well toward the edge or limbus of the cornea, and by the lens with its suspensory ligament. It is perhaps not too much to expect, then, that under the pressure of sustained convergence rendered excessive by bringing the work closer to the eye under poor lighting and other faulty conditions of seeing, the coats

of the eye, more particularly if they are already weak, congenitally or from degenerative causes, should yield in the region of the posterior pole of the eye. It is thought by some (Hasner, Weiss, etc.) that the pull of the optic nerve on the back wall of the eye during convergence may also be a contributive factor in the protrusion or ectasia of the posterior wall. Apparently in the beginning of progressive myopia the protrusion

Fig. 3.—Cross-section of a myopic eye having an axial length of 28 mm. (Figures 3, 4, 5 and 7 are from Fuch: Textbook on Ophthalmology, Philadelphia, J. B. Lippincott Company.)

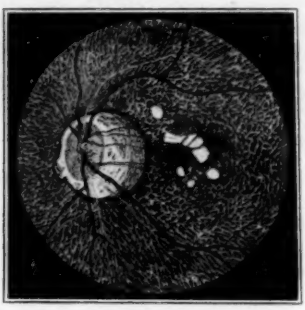

Fig. 4.—Fundus in myopia of high degree.

is confined to a small segment about the posterior pole which enlarges as the myopia progresses. In figure 3 is shown a diagrammatic sketch of the elongation of an eye suffering from a high degree of myopia. Figure 4 illustrates the damage done to the coats of the eye by the stretching which takes place over the region of protrusion.

In figure 5 is given a schematic representation of the blood vessels of the eye; the central artery which, entering with the optic nerve, forms the blood vessel layer of the retina; the system of ciliary vessels which

distributes to the middle or choroid coat of the eye and forms an annular network around the lens (this network is the main source of supply of lymph to the aqueous and vitreous chambers), and the system of conjunctival vessels which distributes to the conjunctiva and forms in conjunction with certain branches of the anterior ciliary artery a marginal loop around the cornea. These systems of vessels supply the lymph

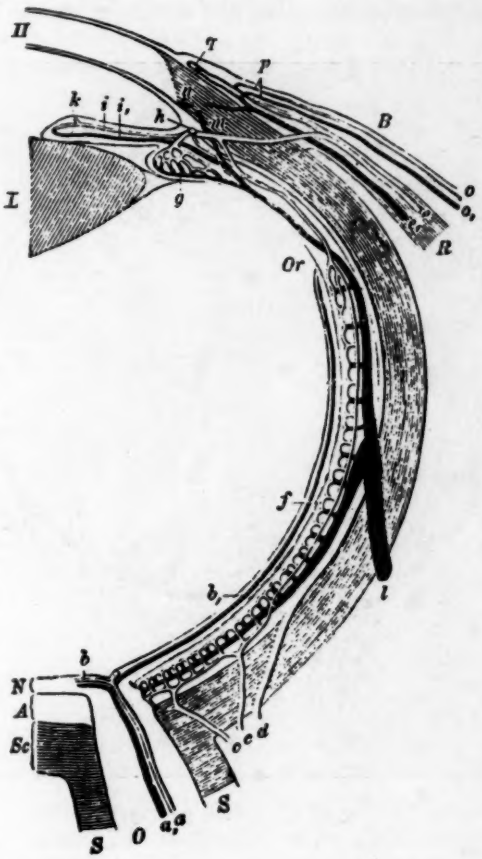

Fig. 5.—Schematic drawing of the blood vessels of the eye. (After Leber.)

which is needed to nourish the eye. The surplus lymph, with the waste products of metabolism, passes out of the eye through certain spaces or channels shown diagrammatically by the shaded portions in figure 6. These spaces are Schlemm's canal, the perichoroidal space and Tenon's space shown, respectively, at *S*, *p* and *t* in figure 6. Schlemm's canal is a tubular space with a porous inner wall which runs around the aqueous chamber at the base of the cornea and communicates directly with

branches of the anterior ciliary vein. It is the principal avenue of drainage for the interior of the eye; that is, the lymph in the vitreous chamber passes through the interstices in the ligament which supports the lens into the posterior portion of the aqueous chamber, around through the pupil into the anterior portion of this chamber, and from there into Schlemm's canal. This canal with its inner porous wall is shown in greater detail at *S* in figure 7. At *D* is shown the sinus between the cornea and iris which is called the drainage angle. It is important

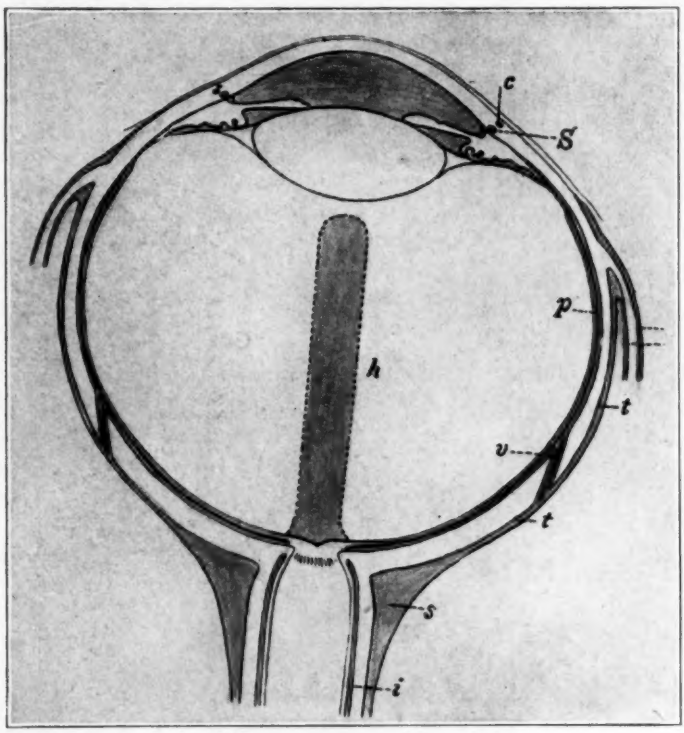

Fig. 6.—Schematic drawing of the lymph passages of the eye. (A system of Ophthalmic Operations, vol. 2, ed. by Casey A. Wood, Chicago, Cleveland Press.)

to the drainage and consequently to the health and safety of the eye that this angle be kept open. Drainage may be impended by the crowding back of the iris into this angle as the result of an undue expansion of the pupil; by congestions, swellings, etc., of the adjacent structures, for example, the ciliary body; by the clogging of the pores opening into the canal with the products of inflammation, of degenerative changes, etc. On the lower half of this plate are shown the following: sections of the cornea, *c;* iris, *i;* the anterior and posterior portions of the aqueous chamber, *ac* and *pc;* the lens with its suspensory ligament the ciliary

body, *cb;* the vitreous chamber, *vc.* The ciliary body contains the muscles of accommodation and the network of blood vessels surrounding the lens. The region around the ciliary body is called the danger zone of the eye because of its liability to inflammation and of the harm that results to the eye from such inflammation.

The perichoroidal space is, as the name indicates, between the choroid and sclerotic coats; and Tenon's space is between the sclerotic coat and Tenon's capsule. These spaces are continuous with the spaces between the sheaths of the optic nerve, and the lymph from the coats of the eye drain back through them into the lymph spaces of the brain. Any impedance in the drainage of lymph from the eye or any undue

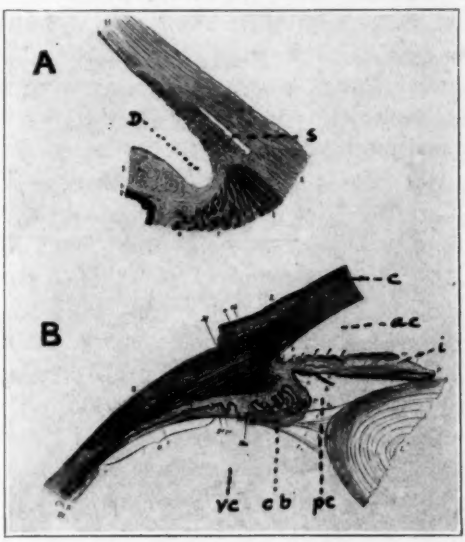

Fig. 7.—*A* shows the sinus of the anterior chamber; *B*, the meridianal section through the anterior portion of the eye.

increase in its supply to the eye causes the pressure or tension within the eye to rise. For example, undue accommodative strain, by causing a congestion of the blood vessels in the network around the lens, might serve to increase the flow of lymph into the aqueous and vitreous chambers, also to impede the drainage of lymph from the aqueous chamber into Schlemm's canal. And any increase of tension in the interior of the eye by exerting pressure on the coats of the eye would impede the drainage through the perichoroidal space and Tenon's space and thus interfere with the drainage of the coats of the eye.

It is pointed out in the foregoing text that the accommodative strain due to bad lighting would tend to cause an increase in the inflow of fluid into the interior of the eye and an impedance in its drainage from

the eye; "that this disturbance in the normal balance of income and outgo would result in a slowly developing hypertension which may be relieved if the coats are weak by a yielding along the anterioposterior diameter or an elongation of the eyeball, and if they are strong, in a damaging pressure on the delicate structures of the retina and nerve-head or a slowly developing glaucoma." We do not mean by this that a measurement of the tension of the cornea by a tonometer would show a supernormal value in cases of myopia thus caused; in many cases at least, the opposite result might be expected, namely, a subnormal tension. That is, in these cases of myopia, the coats are too weak, either congenitally or from degenerative changes, to resist even the normal intraocular pressure. The tendency, therefore, would be to yield until a balance is obtained between pressure and power to resist pressure, and as the conditions continue, this stage or point of balance would tend progressively toward lower levels. Inflammatory processes in the choroid and sclera (sclerotico-choroiditis posterior) by which the sclera is rendered soft and more yielding in the region of the posterior pole are stressed by von Graefe as contributive factors in the cause of myopia.

PIGMENT DEPOSIT IN THE CONTRACTION FURROWS OF THE IRIS *

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Among the common conditions which give rise to dispersement of pigment in the eye are: (1) glaucoma, (2) trauma, (3) inflammation and (4) necrotic melanosarcoma.

The fate of dispersed pigment may be:

1. Absorption.

2. Phagocytosis by lymphocytes. Lymphocytes, unlike polymorphonuclear leukocytes, have a tendency to agglutinate and form small masses of cells. On reaching the anterior chamber these masses precipitate to the dependent part and are seen clinically deposited on the posterior surface of the cornea. They are first grayish in color and their pigment inclusions inconspicuous. But later as the lymphocytes disintegrate, the precipitate becomes smaller and their pigment elements more conspicuous until finally these deposits appear as unadulterated pigment granules. Such is the common fate of pigment set free in uveitis.

3. Distribution in various places as free pigment. Pigment granules have a certain tendency to agglutinate, and any such agglutinated masses may, by virtue of their size, precipitate to the dependent part of the anterior chamber and be seen clinically on the posterior surface of the cornea. But perhaps the majority of the free pigment remains as discrete granules, the specific gravity of which more nearly approximates that of the aqueous, so instead of precipitating they remain more in suspension and thereby enter into the circulation of the aqueous. As this circulation is downward anteriorly (against the cooler and avascular posterior surface of the cornea) and upward posteriorly (against the warmer and vascular iris), these floating pigment granules are thrown against the anterior surface of the iris where they have a rather strong tendency to agglutinate. This appears as fine pigment dust and is seen commonly in glaucoma. This deposition of pigment on the anterior surface of the iris may be diffuse, but it has a certain predilection for the contraction furrows. The pigment may accumulate so abundantly in these furrows that it forms pigment rings at their sites. Such a case is the following:

A boy, aged 8, received a 2 mm. incised wound of the cornea 4 mm. from the limbus at the position of 6 o'clock. During the course of the following five days,

* Submitted for publication, Feb. 5, 1929.

* Presented before the Eye Section of the New York Academy of Medicine, November, 1928.

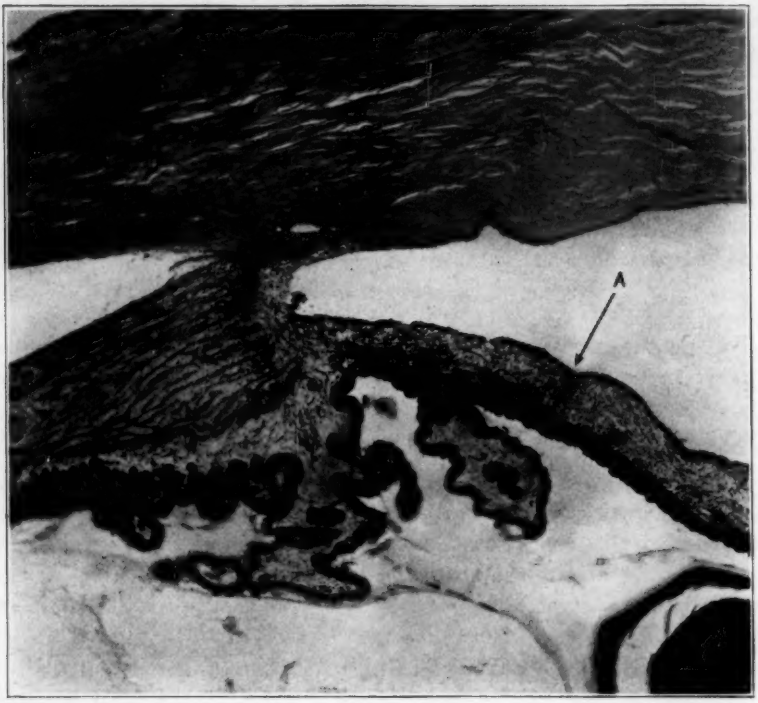

Fig. 2.—Receded traumatic iridocyclitis. *A* represents pigment in the contraction furrow.

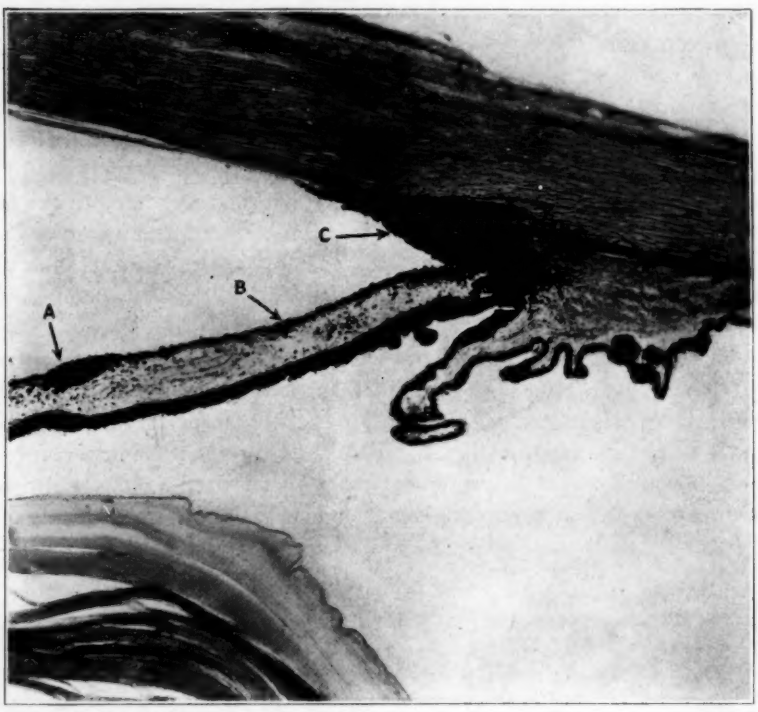

Fig. 3.—Melanosarcoma with dispersement of pigment. *A* represents pigment in the contraction furrow; *B*, pigment on the anterior surface of the iris; *C*, pigment in the dependent angle of the anterior chamber.

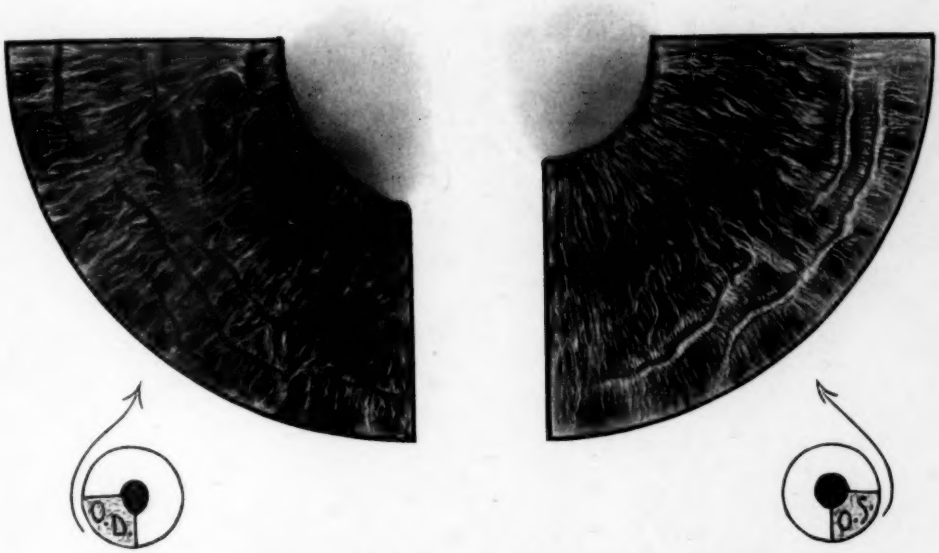

Fig. 1.—Perforating wound of the cornea of the right eye (O.D.) with resulting mild endophthalmitis. The illustration shows: (1) pigment deposit in the contraction furrows of the iris; (2) slight atrophy of the iris stroma allowing the black pigment epithelium to show through more as compared to that of the left iris; (3) anterior border layer slightly more pigmented than that of the left iris. This is due to diffuse dustlike pigment deposition over the anterior surface of the iris. The normal left eye (O.S.) shows that the contraction furrows in a brunette normally contain less pigment than the adjacent stroma and therefore show up as light lines.

there was noted an exudate on the posterior surface of the cornea adjacent to the wound, a weblike exudate on the anterior capsule of the lens in the pupillary area, a barely visible hypopyon in the dependent part of the anterior chamber, a swollen and congested iris and exudative masses in the vitreous. The vision was reduced to the ability to see fingers at a distance of 1 foot, and there was good light projection in all fields. The fundus reflex was barely present, but no details of the back of the eye were discernible. On digital palpation, the intra-ocular tension was perceived to be reduced. The diagnosis was mild ectogenous endophthalmitis. The usual local treatment of hot bathing and administration of atropine was instituted, and in addition thereto three intramuscular injections of milk were given.

Six weeks after the injury, the eye was almost completely white; all exudations had been absorbed except some present in the vitreous; there were no posterior synechiae; the lens was slightly cataractous and swollen below. The slit-lamp showed some pigment deposits on the posterior surface of the cornea and dustlike deposits on the anterior surface of the iris. The patient was able to see fingers at a distance of 2 feet and light projection was good. The fundus, which could be barely seen through the vitreous opacities and the cloudy lens, was normal. The intra-ocular tension was still reduced.

Three months after the injury, I noted with the ordinary oblique illumination and the 4 diameter magnification binocular loupe that there were reddish-brown, concentric lines on the anterior surface of the iris. With this low magnification these lines did not look unlike newly formed blood vessels, and I naturally was somewhat apprehensive lest the eye was showing an exacerbation of inflammatory signs. With a higher magnification, however, these lines were seen to be composed of pigment and to occupy the site of the contraction furrows.

The explanation assumed is that at the time of endophthalmitis some of the dispersed pigment agglutinated or lodged itself on the anterior surface of the iris, and as the dilated pupil made the contraction furrows deeper and more pronounced, the pigment accumulated here more readily and in more abundance. The fact that the patient is a decided brunette with the uveal tract rich in pigment indicates that perhaps more pigment was dispersed at the time of the inflammation than would have occurred in a less pigmented eye.

These pigment lines on the iris were much less pronounced in November, 1928, at the time the patient was presented before the Academy of Medicine, than they were three months before; in other words, the pigment was undergoing absorption.

A LOCALIZED AREA OF CALCAREOUS DEGENERATION IN THE SCLERA

REPORT OF A CASE *

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Present knowledge of calareous degeneration of the sclera is meager. Parsons [1] and Greeff [2] dismissed the subject with a few lines, Parsons stating that calcification of the sclera occurs sometimes in inflammatory processes and in old age, and that the scleral lamellae show an apparently normal histologic structure after removal of the lime salts. In rare cases, actual formation of bone may take place.

That this process was incorrectly diagnosed or entirely overlooked by some of the older authorities is shown by the following fact: Coccius,[3] in his pathologic report of observations on the sclera in a case of glaucoma, remarked on the diffuse fatty infiltration present between the scleral fibers, and on the marked fatty degeneration which had affected the fibrillar interstitial substance and the connective tissue corpuscles of the sclera. Donders,[4] in a paper published later in the same year, stated his opinion that what Coccius described as a fatty degeneration was in reality a deposition of calcium phosphate, a phenomenon that he had frequently observed for many years in the sclera of senile persons.

It is probable, however, that both processes were present in view of the fact that Attias,[5] Krekeler [6] and others found fatty infiltration and deposition of calcium the most striking phenomena present in the

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* Submitted for publication, March 23, 1929.

* From the Eye Department of the University of Graz, Prof. Maximilian Salzmann, Director.

1. Parsons, F. H.: The Pathology of the Eye, New York, G. P. Putnam's Sons, 1904.

2. Greeff, R.: Die pathologische Anatomie des Auges, Berlin, A. Hirschwald, 1902.

3. Coccius, A.: Beitrag zur Lehre vom Wesen des Glaucoms und zur Heilwirkung der Iridektomie, Arch. f. Ophth. **9**:19, 1863.

4. Donders, F. C.: Ueber einen Spannungsmesser des Auges, Arch. f. Ophth. **9**:217, 1863.

5. Attias, G.: Ueber Altersveranderungen des menschlichen Auges, Arch. f. Ophth. **81**:457, 1912.

6. Krekeler, F.: Die Struktur der Sklera in den verschiedenen Lebensaltern, Arch. f. Augenh. **93**:155, 1923.

progressive metamorphosis of the scleral fibers in the sclerae of old persons. The frequency with which these two pathologic processes are associated led Krekeler to believe that the latter process is derived from the former. Attias stated it as the opinion of the authorities that the infiltration of calcium present in senile changes of the sclera is a residuum from the saponified fat.

According to Krekeler, the infiltration of fat and the deposition of calcium in the sclera of senile people take place between the scleral fibrils, the fibrils themselves, as well as the scleral cells, remaining free from the degenerative processes. The calcium salt may be either the carbonate or the phosphate or both. The phosphate predominates and appears in the form of coarse granules readily distinguished in surface or meridional sections with the hematoxylin stain, or more readily if left exposed to light in a 1 per cent solution of silver nitrate for several hours.

As to the localization of the depostion of calcium in the sclera, Krekeler stated that the equatorial region is the region of predilection, the posterior half of the sclera being little involved. Attias, on the other hand, expressed his belief that the deposition of calcium in the sclera increases from the equator toward the optic nerve. The pathologic process in Coccius' case, which Donders was certain was calcium infiltration, extended throughout the entire length of the sclera, from its most anterior region to the optic nerve.

The only report of a localized area of calcareous degeneration of the sclera which I have been able to find is that by Pagenstecher.[7] The pathologic process of this localized lesion appears in some respects to be similar to that of the case herewith presented, whereas the associated changes in the adjacent tissues are markedly different. Pagenstecher's report deals with the observations in an atrophic eyeball in which calcification was present in the lens, choroid and retina, as well as the sclera, and in which ossification was present in the choroid. The cause of the atrophy is not stated, nor can it be definitely ascertained from the description given, although one is led to believe, from the course and pathologic observations in the fellow eye, that the most probable cause of the atrophy was glaucoma. The area of calcareous degeneration was 2 mm. long and 0.5 mm. wide: the depth was not stated. It was located in the anterior portion of the sclera in the region of the ciliary muscle. That the process was extending in all directions was evident from the presence of smaller and larger "drusen-like bodies" around the edges. Pagenstecher, no doubt, referred there to the calcareous granules which are the first deposited and which coalesce to form round or irregular

7. Pagenstecher, A.: Beiträge zur pathologischen Anatomie des Auges, Arch. f. Ophth. **7**:118, 1860.

nodules or laminae. After the removal of the calcium the scleral fibers of the involved area were normal and could not be differentiated from the scleral fibers of the surrounding uninvolved region. This differs from the observations in the case presented in that the circumscribed area of calcareous degeneration was markedly altered from the normal state, and therefore was much different from the surrounding sclera when sections were treated with dilute hydrochloric acid in order to remove the calcium.

The history and the clinical and microscopic observations of the eye studied by me are as follows:

REPORT OF CASE

A man, aged 76, had been suffering with pain in the right eye for almost a year. The pain radiated to the forehead and was accompanied by inflammatory symptoms. There was also a noticeable failing of vision.

The right eye showed a clear cornea. There were two dilated, tortuous ciliary vessels on the temporal side which penetrated the sclera near the limbus and apparently passed forward on the anterior surface of the iris to the pupillary margin. The upper vessel passed along the temporal, upper and nasal pupillary margin, to unite with the lower vessel which passed along the temporal, lower and nasal pupillary margin. From the ring thus formed, fine branches were given off which passed outward to the periphery of the iris. Other than these two dilated ciliary vessels, nothing abnormal was seen in the temporal sclera. The anterior chamber was shallow. The iris was greenish, and its structure was not clearly defined. The pupil was slightly oval horizontally and immovable. The lens was cataractous and the fundus was not visible. The tension was 38, and there was no perception of light. The eye was enucleated.

The left eye showed a normal appearance externally. Examination with the ophthalmoscope revealed a shallow excavation of the disk extending to the margin. A halo was present. The tension was 22. L. V., with + 2.25 diopters sphere = 0.7. The field was normal.

The hardened enucleated eyeball was of normal size. The cornea became folded. Therefore the nasal side of the anterior half of the eyeball was sectioned vertically, whereas the temporal half was sectioned horizontally. The posterior half of the eyeball was also sectioned horizontally.

Microscopic examination of the anterior half of the eyeball showed the cornea little changed from the normal. Only at the periphery were there small, isolated, newly formed areas of vascularized connective tissue between the epithelium and Bowman's membrane—pannus degenerativus. The stroma and Descemet's membrane were normal. The anterior chamber was shallow and of irregular depth due to the folding of the cornea. Its depth, therefore, could not be measured correctly. It was filled with a granular coagulum. The iris showed a typical peripheral synechia which extended a little anterior to the end of Descemet's membrane. It was atrophic throughout, therefore thinner than normal, but especially so in the free part. The anterior surface was flat, showing no relief, and was covered by a cicatricial membrane which contained numerous lumina of blood vessels. This membrane, as well as the blood vessels, extended into the membrane covering the pupil. The pupillar membrane was thickened at the periphery and rather thin in the center, giving the typical appearance of occlusio pupillae. The canal of Schlemm was partially obliterated, but the blood vessels which united

the canal of Schlemm with the anterior ciliary veins were open and contained blood. The pectinate ligament showed no holes, the trabeculae being applied to each other, but preserving their normal appearance. The nuclei of the endothelium were reduced in number. The ciliary body was of fairly normal appearance, the processes and muscle being well developed. The blood vessels were markedly dilated and almost completely filled with blood, making it difficult to differentiate arteries from veins. Evidently a passive hyperemia was present. The large blood vessels of the ciliary body appeared to extend into the vascularization of the iris. The pars ciliaris retinae and the zonula fibers were normal. The lens was cataractous, the cortex being partially replaced by Morgagnian globules and fluid. The periphery of the retina was atrophic. The rods and cones were missing in a zone 2 mm. wide at the ora serrata. The nuclei of both nuclear layers were reduced in number. Few cystoid spaces of Blessig were present. The periphery of the vitreous was apparently normal, whereas the center was of slightly fluid consistency.

The posterior half of the eyeball showed complete atrophy of the optic nerve. The septums were thickened, the nerve bundles narrower; the distribution of nuclei in the nerve bundles was irregular. The lamina cribrosa was slightly concave. The tissue of the disk was atrophic and was present only in the nasal half, filling out the angle between the lamina cribrosa and the foramen opticum sclerae. The atrophy on the temporal side had progressed so far that only a delicate stratum of atrophic nerve tissue was present on the surface of the lamina cribrosa. The border of the papilla therefore formed a sharp step. The blood vessels of the papilla showed thickened walls and a narrow lumen. The central vein as it entered the lamina cribrosa was transformed into a solid mass of connective tissue. Farther behind in the lamina cribrosa it existed only as a narrow lumen which had no connection with the veins on the papilla. The retina showed an entirely normal neuro-epithelium. The internal nuclear layer was slightly atrophic. The ganglion cells as well as the nerve fibers were entirely missing, so that only the fibers of Mueller were present from the inner surface of the internal plexiform layer to the internal limiting membrane. The membrana limitans interna was unusually thick. On the nasal side of the optic nerve, where a slight detachment of the vitreous was present, another membrane lining the external surface of the vitreous was well defined and readily visible. This was a regular hyaloid membrane differing from the limitans interna. The space between the two membranes was partially filled with a fine delicate granular substance. An intense cystoid degeneration was present in the region of the area centralis, and produced an irregularity of the inner surface of the retina in this area. The cysts lay mostly in the internal nuclear layer, although some extended outwardly as far as Henle's outer fiber layer. The immediately adjacent area of the fovea was free from this cystoid degeneration. The pigment epithelium was normal, and the retina was everywhere applied to the normal choroid.

In the sclera, anterior to the insertion of the tendon of the external rectus muscle, near the ora serrata, lay a localized, well defined area of calcareous degeneration (fig. 1). This degenerative area measured 1.75 mm. horizontally and 1.9 mm. vertically and was 0.31 mm. thick. It lay entirely within the sclera, separated from both surfaces by strata of sclera in which no nuclei were present. This localization explains why the condition was not noticed clinically or in the enucleated bulb. Except for this area of calcareous degeneration and the surrounding necrotic bundles, the sclera was normal. The sections were 15 microns thick, and no difficulty was experienced by the technician in sectioning this area of the eyeball.

Examination with a loupe of the degenerated area in an unstained section showed a pure white, slightly irregular, linear center which was surrounded by a much broader, more refractile light yellow area. The latter area was well demarcated from the surrounding sclera.

An unstained section was placed on a glass slide and covered with a cover glass, along one edge of which a drop of dilute hydrochloric acid was placed. The area of calcareous degeneration was kept constantly under microscopic observation. The advancing edge of the hydrochloric acid could be seen as it passed over the calcareous area, the sharp outline of which disappeared rather rapidly, the whole becoming transparent, leaving only a substratum of a few irregular, wavy horizontal striations. In some cases an empty space, except for small solid masses of residuum, was left. The chemical change brought about by the action of hydrochloric acid on the calcium compound present was not attended with the formation

Fig. 1.—Temporal portion of anterior half of eyeball stained by hematoxylin-eosin, showing size and location of the calcareous degenerated area.

of gas bubbles, and this led to the belief that the phosphate of calcium was the sole calcium salt present. Later, however, a number of unstained sections were treated in a similar manner, and in the majority of instances gas bubbles, varying in number from one to five or six, developed simultaneously with the appearance of the hydrochloric acid over the degenerated area. I am led to conclude, in view of the fact that the carbonic acid gas was not present in all cases, and when present varied quantitatively, that the carbonate was not deposited equally throughout, that it was entirely absent or if present, only in an infinitesimal amount in those sections in which no gas bubbles were produced.

The degenerated area showed the following details when stained with hematoxylin-eosin (fig. 1): There was a central part corresponding in size and location to the linear pure white central area of the unstained section, which

showed only an intense hematoxylin stain. There were slits in this part which did not resemble the normal structure of the sclera; the whole mass, therefore, appeared irregularly broken. Around this was a zone which showed a lesser hematoxylin stain with a little of the eosin stain. The scleral bundles could be seen in this zone. They showed no marked difference from normal scleral bundles except for the stain. Small island-like areas of normal sclera which had escaped the degenerative process, although they lay in the degenerated calcareous area, were seen in several sections in different locations. The peripheral zone was characterized by the presence of innumerable granules staining from violet to purple. These varied in size and shape; the majority were round, and the largest were the size of a red blood cell. They had a tendency to coalesce and form larger bodies which were either nodular or rectangular. They were scattered throughout all parts of the bundles and were no doubt the bodies which Pagenstecher referred

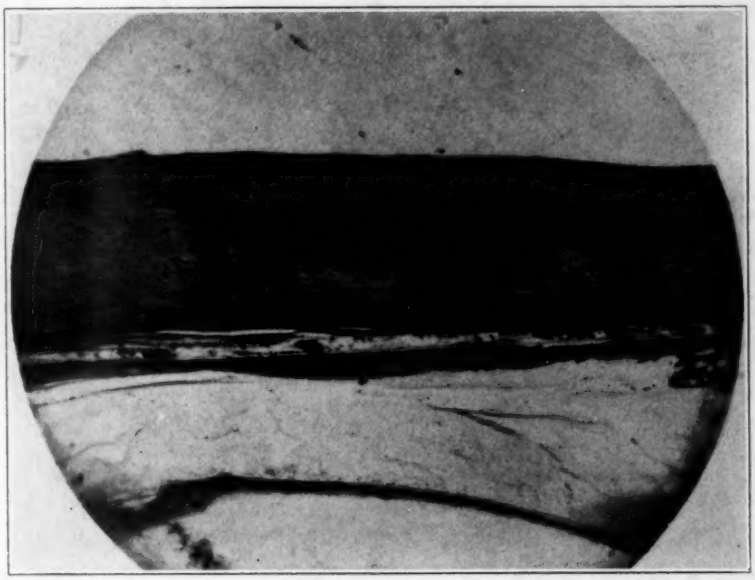

Fig. 2.—Section stained for three hours with a 1 per cent solution of silver nitrate.

to as the "drusen-like bodies." No hyaline bodies were present. There were no signs of inflammation around the degenerated area. There was so little episclera left in this region that its condition could not be correctly determined. An intrascleral nerve loop, unaccompanied by a vessel, was present 0.45 mm. above the middle of the upper surface of the degenerative area.

Six unstained sections were then placed in a 1 per cent solution of silver nitrate which was left exposed to daylight. Two sections were left in the solution for one hour, two for two hours and the remaining two for three hours. They were then mounted in the usual manner. The area of calcareous degeneration was sharply demarcated from the surrounding normal sclera in all sections. In the sections that were stained for one hour the center linear area was stained a light brown, a color which steadily increased in intensity to a dark brown containing rather diffuse, black granular-like areas throughout. The surrounding peripheral

portion stained a light brown, gradually changing to a golden brown. This increase in the intensity of color was still present in both parts many hours after the sections were mounted. The sections kept in silver nitrate for two hours displayed the same characteristic features as those previously described, and went through identically the same course when mounted except that the coloration was more intense throughout. The centers of the sections kept in the silver nitrate solution for three hours were dark brown when mounted, and rather rapidly changed to a black (fig. 2). This reaction was brought about by the formation of a black silver phosphate as a result of several hours' action, in daylight, of a 1 per cent solution of silver nitrate on the calcium phosphate present (Kossasche's reaction). The periphery showed a corresponding increase in density of color, so that it finally appeared as a dark brown.

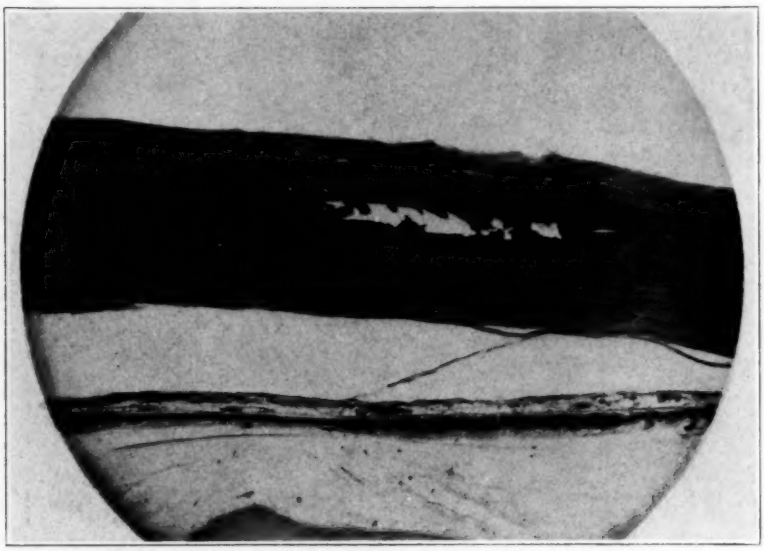

Fig. 3.—Section treated with dilute hydrochloric acid and then stained with hematoxylin-eosin.

The sections which were treated with dilute hydrochloric acid were then stained, either by the hematoxylin-eosin method or with a 1 per cent solution of silver nitrate, for three hours. The small amount of tissue left in the central clear area of the sections stained by the former method was composed mostly of an amorphous residuum, or small areas containing a few short lengths of thickened, irregular scleral fibers (fig. 3), staining lavender to violet, but nowhere as intense in color as that seen in the hematoxylin-eosin stained sections not treated with hydrochloric acid. The remainder of the degenerated area was completely intact, staining much lighter purple than the corresponding region in the untreated hematoxylin-eosin stained sections. The small, round, nodular or laminar-shaped granules in the peripheral zone were indistinctly seen. The most marked degeneration evidently occurred in the central area which, when acted on by hydrochloric acid, was partially dissolved and partially broken into loose pieces so that an almost empty space appeared. Because of the absence of phosphates which had

been dissolved by the hydrochloric acid, Kossasche's reaction did not occur in the decalcified sections which were later stained with silver nitrate (fig. 4). The small amount of tissue remaining in the central linear area, as well as in the entire surrounding, degenerated zone, stained a light brown by this method, a much lighter color than that of the corresponding areas in sections similarly stained but not treated with hydrochloric acid.

COMMENT

A brief recapitulation of the salient features of this case shows what I believe to be the only reported instance of an isolated, well defined area of calcareous degeneration in the sclera of a bulb which had not become atrophic, in which there was not even a deposition of calcium

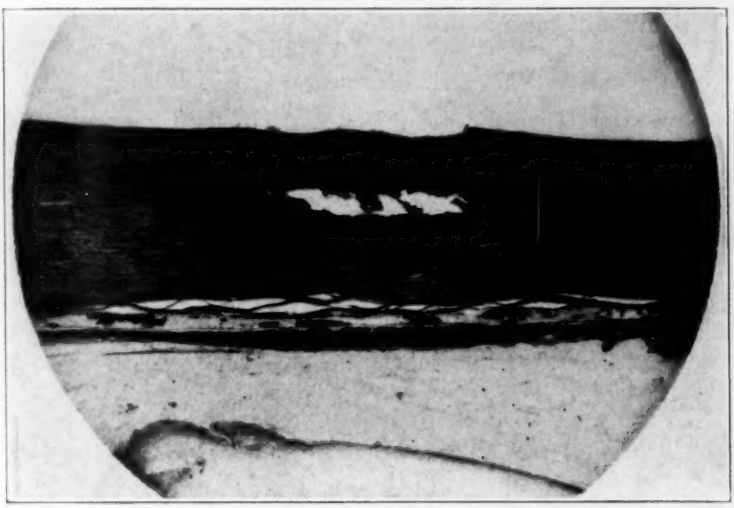

Fig. 4.—Section treated with dilute hydrochloric acid and then stained with 1 per cent solution of silver nitrate for three hours.

between or in the rest of the scleral fibrils—a frequent phenomenon seen in the regressive metamorphosis of the sclera in aged persons (Krekeler)—and in which no other areas of calcareous degeneration were present in any of its tissues. The scleral tissue which had undergone calcareous degeneration was not a cicatricial tissue. There was no previous inflammation in this area, and, on the other hand, there was no secondary inflammation. The degeneration was due to the deposition of both the carbonate and the phosphate of calcium, the deposition being as marked in the scleral bundles as between them. The degenerated process was evidently progressive; it began with the deposition of granules; it progressed to a later stage of complete imbibition of scleral tissue with lime salts, and it terminated with destruction of scleral tissue.

Pathologists [8] subdivide the pathologic disturbances in calcium metabolism into two groups: One group consists of cases in which there is an inadequate supply or excessive withdrawal of calcium; the second group, of which the present case is an example, contains those cases in which the reverse occurs and the tissues become the seat of abnormal accumulation of lime salts. In both instances, the disturbance may be local or general. It is extremely common to find calcified masses in tissues that have become necrotic. It seems probable that even in those tissues which are homogeneous in their normal state, calcification takes place only after they have become dead. It has been shown that the lime salts deposited in dead tissues are generally the same and in the same proportion as those in bone, about 13 per cent of calcium carbonate and 87 per cent of calcium phosphate.

CONCLUSION

In conclusion, I wish to call the attention of the reader again to the fact that no nuclei were found in the surrounding scleral tissue. One might conclude from this that the sclera evidently became necrotic in this area, and that later the deposition of calcium took place. It is impossible to decide whether or not this process had any connection with the glaucoma. It would be interesting to search for similar conditions in cases of chronic glaucoma.

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8. MacCallum, W. G.: Textbook of Pathology, Philadelphia, W. B. Saunders Company, 1924.

TRANSPLANTATION OF THE TEMPORAL HALF OF THE VERTICAL RECTI TENDONS IN A CASE OF COMPLETE PARALYSIS OF THE EXTERNAL RECTUS *

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Because of the infrequency of operative attempts to relieve complete paralysis of the extra-ocular muscles, because of the varied results secured and up to this time reported, and because of the favorable result obtained in this case and the simplicity of method and technic employed, the report of this case is presented. In incomplete paralysis with motility of the globe reaching to the median line of rotation, favorable results by advancement or resection of the muscle and tenotomy of the opposing muscle are well known. Cases of complete paralysis, however, are usually regarded as beyond surgical relief, and accordingly are, as a rule, dismissed or an attempt to improve the cosmetic appearance is made by various well known methods.

Tendon transplantation in general surgery is practiced daily, and dates back to 1770, when Missa [1] first restored the function of a finger by substituting other tendons to a severed extensor. The method of transplantation or attachment has been a question of dispute, presumably based to some extent on the variations in the character of the paralysis or deformity, but more especially on the functional results attributed to the particular method employed. Mayer [2] stated that the present systems are empiric rather than rational, as is shown by the marked discrepancy in the operative methods of prominent orthopedic surgeons. Lange, with an experience of more than 2,000 tendon operations, is opposed to Vulpius, whose experience is almost as great. Lange insisted on the periosteal implantations of the tendon, and lengthens the tendon artificially by silk strands. Vulpius pointed out the advantages of sewing the transplanted tendon to the paralyzed tendon as advocated by Nicoladoni [3] in 1882.

Tendon transplantation of the ocular muscles is not at all a recent development in ophthalmic surgery, when it is recalled that Parinaud [4]

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* Read at the New York Academy of Medicine, Section of Ophthalmology, Jan. 21, 1928.

1. Missa: Gaz. Salut., 1770, no. 21.
2. Mayer, L.: Surg. Gynec. Obst. **22**:182 (Feb.) 1916.
3. Nicoladoni, cited by Waterman, J. H.: Med. News, July 12, 1902.
4. Parinaud: Noveau procédé operatoire du ptosis, Ann. d'ocul. **118**:12, 1897.

in 1897, and Motais [5] in 1898, brought forth their methods of correcting ptosis by transplantation of a portion of the superior rectus tendon.

In 1908, Edward Jackson,[6] before the ophthalmic section of the American Medical Association, advocated the transplantation of extraocular muscle tendons in cases of paralytic squint, and in 1903, the same author reported two cases of paralysis of the superior oblique in which transplantation of the superior rectus was made to a new insertion farther backward and outward from its normal insertion, thus relieving the tendency of the eye to turn upward, and at the same time increasing the power of intorsion and abduction. In both cases relief from distressing symptoms of headache, dizziness and diplopia was accomplished. Two and one-half years afterward there could be elicited only a small degree of hyperphoria in one patient (aged 45 years), and a similar result was secured in the second patient (aged 41 years). The theoretical analysis of the subject and its practical application outlined in this paper are illuminating and convincing, and the results reported bear testimony of both.

Several experimental operations on monkeys were performed by Hummelsheim,[7] in 1907, who transplanted the nasal halves of the tendons of the superior and inferior recti to the attachment of the internal rectus after producing operative paralysis of the internus. The results of these experiments were unsatisfactory.

As the result of this experience and the verbal report of a case by Marina, Hummelsheim [8] performed a similar operation on two patients, which he reported in 1908. One of these was a girl, aged 12 years, with congenital paralysis of the right abducens. The eye could not be turned outward beyond the median line. The temporal halves of the superior and inferior recti were transplanted, and the result was an abduction of 30 degrees without any loss of vertical rotation. Binocular vision, however, was not obtained. The second case was that of a woman, aged 47, with acquired paralysis of the abducens of eight months' duration. The result of the operation was cosmetically satisfactory when the patient looked directly forward; there was, however, some limitation of upward rotation, but no limitation in rotation downward.

In 1912, Stuelp [9] reported the transplantation of the vertical recti tendons in a case of marked convergent paralytic strabismus. Tenotomy

5. Motais: Operation du ptosis, Bull. et mém. Soc. franç. d'opht., 1898.

6. Jackson, E.: Operation on the Tendon of the Superior Rectus Muscle for Paresis of the Superior Oblique, Ophth. Rev. **22**:61, 1903.

7. Hummelsheim, E.: Ueber Sehnentransplantation am Augen, Tr. 34th Ophth. Cong., Heidelberg, 1907, p. 248.

8. Hummelsheim, E.: Weitere Erfahrungen mit partieller Sehnenüberpflanzung an den Augenmuskeln, Arch. f. Augenh. **62**:71, 1909.

9. Stuelp: Partieller Sehnenüberpflanzung bei kompletter traumatischer Abducenslähmung, Klin. Monatschr. f. Augenh. **50**:467, 1912.

of the internal rectus was performed three weeks afterward when there was improvement in the cosmetic result.

In 1917, H. W. Woodruff [10] reported two cases of paralytic convergence, in which he performed partial tendon transplantation of the vertical recti muscles. In one case there was definite improvement with slight convergence and no rotation outward. In the other case, he stated that the result cosmetically was better, but functionally the same, as there was no rotation outward beyond the primary position. Dr. Woodruff, however, did not give himself credit for the exceptionally good cosmetic result secured in this case.

In 1914, McDannald [11] reported a case of "sursumvergence," believed to be due to the absence or complete paralysis of the inferior rectus muscle in a man, aged 31. Tenotomy of the superior rectus and transplantation of a portion of the internal and external recti to the point of attachment of the inferior rectus were performed. The cosmetic appearance was improved.

In 1919, Dr. O'Connor,[12] in reporting the case of a child, aged 8 years, with abducens paralysis on whom was performed transplantation of portions of the vertical recti tendons to strips of the external rectus tendon, related a most unusual functional result of 45 degrees outward rotation, no diplopia "within limits of glasses" and a "perfect cosmetic result." The report, however, is incomplete as to functional tests previous to operation, and the question of complete paralysis of the external rectus arises, since "outward rotation even to the primary position could not be demonstrated," the external rectus was shortened, and the rotation outward was 25 degrees before tenotomy of the internal rectus was performed.

In 1921, Sweet [13] reported a case similar in many respects to that of O'Connor, and in which he secured an outward rotation of 20 degrees, increased to 35 degrees after tenotomy of the internal rectus. In the discussion of Sweet's case, Peter [14] related a case in his own experience with similar results. Posey,[14] in this discussion, referred to a case of upward squint believed to be due to absence of the inferior oblique, in which he transplanted the inferior half of the internal and external recti to the attachment of the inferior rectus, at the same time making

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10. Woodruff, H. W.: Tendon Transplantation of the Eye Muscles, Tr. A. M. A., Sect. Ophth., 1917, p. 276.

11. McDannald, C. E.: Case of Sursumvergens, Arch. Ophth. **43**:515, 1914.

12. O'Connor, R.: Transplantation of Portions of Vertical Recti for Abducens Paralysis, Am. J. Ophth. **2**:197, 1919.

13. Sweet, W. M.: Tendon Transplantation in Paralysis of the External Rectus, Am. J. Ophth. **4**:866, 1921.

14. Peter, L. C., and Posey, W. C., in discussion of Sweet: Am. J. Ophth. **4**:866, 1921.

a free tenotomy of the superior rectus. The squint was entirely corrected, the eyes being on a horizontal plane, and there was some rotation of the eye downward.

In 1928, Rodin and Swett [15] reported a case similar to that of Sweet, in which there was no "abduction of the eye beyond the primary position." The result shown by photographs was most satisfactory; rotation outward was about 35 degrees.

In any report on true paralytic squint, I believe it is most important to designate sharply between complete paralysis and partial paralysis of the muscle. This may not be possible in certain cases, as, for example, in retraction after injury, in contraction of the antagonist in partial paralysis, or in congenital shortening of the opposing muscle with rotation reaching to or almost to the median line. Complete paralysis, however, cannot be doubted when there is no rotation outward from the fixed position of convergence of 45 degrees. This was the position and condition of the eye on which I felt justified in performing the partial tendon transplantation of the vertical recti muscles in the case now to be reported.

REPORT OF CASE

Harry H., a boy, aged 6½ years, came to the New York Eye and Ear Infirmary on May 14, 1928. Briefly, the history, according to his mother, was that at birth she believed both eyes were normal, but about the seventh month the left eye suddenly turned inward and had remained so since that time. He was in excellent health and no cause could be found to account for the defect. Two years later he had been sick with measles, and a year later with chickenpox and German measles, but there was no other history of illness, nor was there any history of injury. He had worn glasses constantly since the age of 3 years, and without any effect on the converging eye.

On examination, the right eye was found to be normal; the motility was normal, and vision was 20/20 (the error of refraction was +0.25 diopters +0.50 diopters × 15). The left eye was convergent 45 degrees, with no rotation outward from this fixed position in convergence; rotation upward and downward was limited slightly, with slight tortion in both directions; the eye was normal and the vision 20/40, improved to 20/30 with a —0.50 diopter + 1.25 diopters × 165 lens. There was no diplopia and no squinting to avoid it.

The diagnosis of congenital complete paralysis or absence of the external rectus (left eye) was made, and operation was advised only for cosmetic improvement.

On May 22, 1928, operation was performed with the patient under ether anesthesia, when the external rectus (only a bundle of loose elastic tissue) of the left eye was resected after the Reese method, and the temporal halves of the superior and inferior recti tendons were transplanted beneath the resected external rectus and attached to the tendon insertion of this muscle; tenotomy of the upper half of the internal rectus was then performed.

The procedure briefly was as follows: The external rectus was resected in the usual manner after the Reese technic (fig. 1), care being taken to free the

15. Rodin, F. H., and Swett, W. F.: Tendon Transplantation for Paralysis of External Rectus, Am. J. Ophth. **11**:369, 1928.

muscle laterally a little further posteriorly than is commonly necessary. The rectus was found to be a flabby bundle of elastic tissue apparently without muscle fibers. The sutures were placed through the rectus in the usual manner, but not through the tendon stump insertion at this time. Number 6 twisted silk was used for the wing sutures. Now the superior rectus was dissected free at its insertion and spread on the muscle forceps, when a division of its fibers was made partly by blunt dissection as well as by sharp dissection posteriorly, the direction of course being backward and slightly to the nasal side. The upper arm of the double or central suture of the resected external rectus was then carried from without inward through the temporal border of the superior rectus tendon, and the upper wing suture was carried from without inward through the nasal border of the temporal half of the superior rectus. The temporal half of the superior

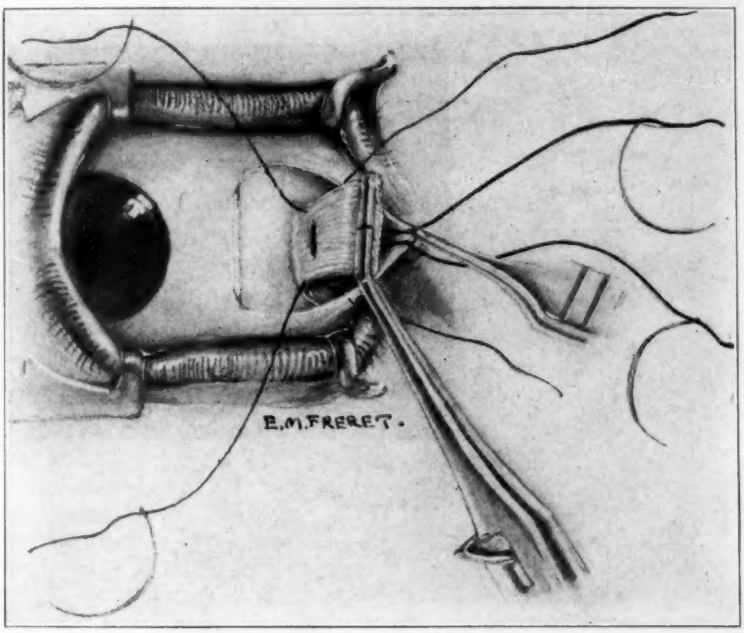

Fig. 1.—Sutures placed in the original Reese resection (A. B. Reese).

rectus was then divided at its insertion. The inferior rectus was similarly dissected in half and similarly sutured with the lower arm of the double suture and lower wing suture of the resected external rectus (fig. 2). These four sutures, now including the tendon of the external rectus and the temporal halves of the vertical recti beneath it, were then placed deeply through the tendon stump or insertion of the external rectus (fig. 3).

Tenotomy of the upper half of the internal rectus was then performed. On making the incision for tenotomy, the conjunctiva was found to be foreshortened or insufficient, probably from lack of development due to the long continued and almost fixed convergent position of the globe since babyhood, if not since birth. Although the dissection was carried well beneath the caruncle, there was noticeable retraction here presumably due to this congenital defect. The "open" tetomy technic was followed in order to make more accurately the incision of the

upper half of the tendon. Both eyes were bandaged for three days, but were dressed daily. The bandage was not restored on the tenth day, when the sutures were removed.

As to the result of this operative effort, it could be noted that on fixation at a distance there was about 5 degrees of divergence, and on fixing at 30 inches (76.20 cm.) there was approximate parallelism (fig. 4, *A*). The tropometer measured 20 degrees internal rotation (fig. 4, *B*), 15 degrees outward rotation, with slight tortion downward (fig. 4, *C*), 15 degrees upward, and 20 degrees, equal to the fellow eye, downward. There was no retraction of the globe, nor was there any prominence according to exophthalmometric measurements. The palpebral fissure was approximately identical with that of the fellow eye (fig. 4, *A*). There

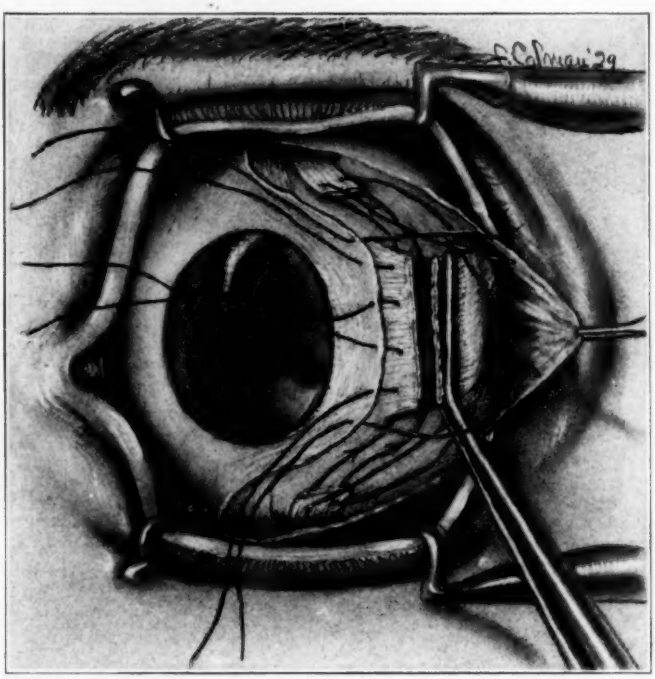

Fig. 2.—Sutures placed just prior to excision of the external rectus portion held in forceps, when the sutures were tied.

was moderate retraction of the caruncle, due to the conjunctival anomaly previously mentioned. Cosmetically, the result appeared to be only that which could be anticipated in such a case. For a period of three weeks following the operation the patient complained of diplopia, and for about two weeks there was noted the characteristic squinting to avoid it. Since that time, however, these symptoms have entirely disappeared. Muscle exercises are being practiced daily to secure improvement, if possible, in the functional result.

COMMENT

It is unfortunate that photographs cannot be shown to demonstrate the total loss of abduction of this eye (left) previous to the operation,

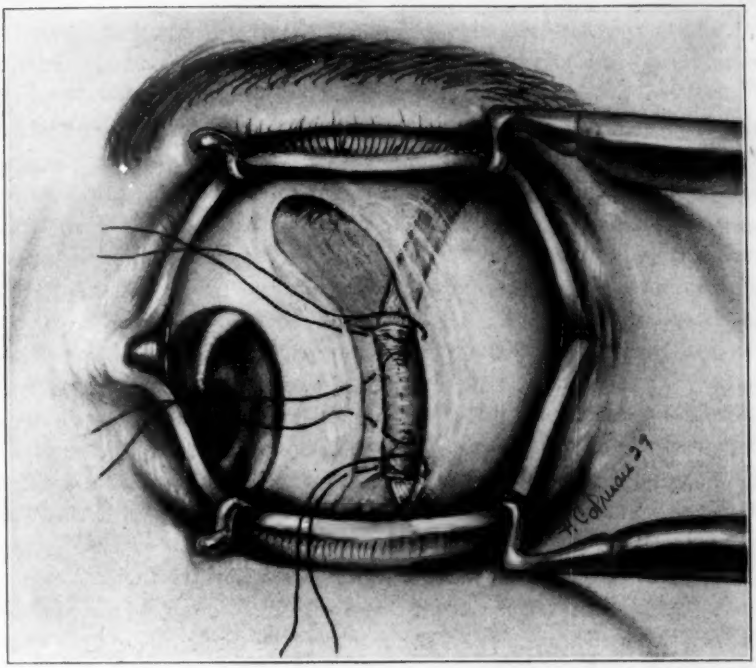

Fig. 3.—Tendon strips drawn in position, when the sutures are tied.

Fig. 4.—*A*, photograph at distance of 30 inches, seven months after operation. The eyes are in parallelism, and there is no prominence or retraction of the globe; *B*, rotation of the left eye inward measures from 20 to 25 degrees; *C*, rotation of the left eye outward measures 15 degrees.

because it could not be rotated outward the slightest degree from its position in convergence during extreme rotation of the right eye to the left. Although these photographs could be of little practical value, they would serve to emphasize the unmistakable diagnosis of complete paralysis of the external rectus in this case in contradistinction to those cases in which motility reaches to or almost to the median line of rotation, and which, therefore, cannot be accepted as cases of complete paralysis. In this connection one is reminded that some explanation is necessary in those cases in which transplantation of the vertical recti apparently has resulted in 30 degrees of external rotation (as reported by Hummelsheim, O'Connor, Sweet, Rodin and Swett). One concludes that paralysis was not complete in these cases and that the excellent functional results were due to resection or advancement of the external rectus with tenotomy of the internus. Woodruff's cases, on the other hand, and those reported by McDannald and Posey tend to show that while restoration of function may not be possible to any degree by partial tendon transplantation, improvement in the strabismus for the cosmetic result is accomplished. Woodruff's explanation for this, taken from Mayer, may seem plausible, i.e., "the failure to secure external rotation in these cases is probably due to adhesions, so that the superior or inferior recti do not act from the point of insertion, but at the point at which the tendons are split, the transplanted tendon flaps acting more as ligaments to hold the eye outward, especially after tenotomy of the internal rectus." To me, however, the simple explanation is found in the nerve supply and associated action of the muscles involved. On external rotation there occurs contraction of the external rectus supplemented by the obliques together with relaxation of contraction of the internus and vertical recti—an associated act with associated nerve control. The nervous relationship does not permit associated contraction of the vertical recti with the external rectus and obliques in external rotation. Then why should one expect a functional result from the transplanted vertical recti tendons (although they may be capable of function, per se) in the act of external rotation? Beyond that degree of function which may be attributed to the concerted action of the obliques when the globe is rotated to (or held in) or beyond the primary position, it seems unreasonable to anticipate.

CONCLUSIONS

In my case report it is of interest to note:

1. The conjunctival incision passed almost completely about the cornea, only a small section, about 5 mm. in extent, remaining intact in the lower nasal quadrant.

2. The internal rectus was a strong and functioning muscle as evidenced by its appearance and by the internal rotation of 20 degrees after operation, when tenotomy of one half of its tendon was performed. Complete tenotomy of the internal rectus would no doubt have resulted in a divergence of the globe.

3. The external rectus was a thin elastic sheath without muscle fibers, not fibrous or comparable to that found in Duane's syndrome, but in every respect that to be anticipated in congenital complete paralysis or absence of the muscle. Resection was made for the purpose of adjustment of Tenon's capsule in the transplantation of the vertical recti tendons and for whatever advantage might be gained thereby. It is my opinion that the resection of the external rectus bundle was perhaps unnecessary. Because of the possible traction from the strong opposing internal rectus, and because of the fragile external rectus bundle with the small vertical recti tendon strips included in the same sutures, these sutures were not tied to the external rectus stump until tenotomy of the upper half of the internal rectus had been performed. Obviously, this procedure was for the purpose of avoiding traction on the sutures. It is of importance to note that in the simple technic employed each vertical rectus tendon strip is sutured with two different sutures at different attachments, and that the folding in of the cut edge of the external rectus against its insertion (produced by the method of placing this suture) thus retracts the temporal cut edge of the tendon strips, so that their attachments are at an angle to the external rectus insertion and therefore somewhat perpendicular to the direction of the muscle action.

4. The vetrical recti tendon strips were not excised until transplantation to their new insertion was to be made at once. Their function in abduction is questionable, but as an elastic band support to the globe, they no doubt tend to hold the eye in the primary position, and thus permit and perhaps aid the obliques in their subsidiary function of abduction to rotate the eye outward 15 degrees.

5. From the study of this case, it seems reasonable to conclude, that transplantation of the temporal half of the vertical recti tendons is advisable in those cases of complete paralysis of the external rectus muscle, in which diplopia may not occur as an intolerable complication (in childhood or when the converging eye is amblyopic). It also seems indicated in cases of incomplete paralysis of the external rectus when resection or advancement with tenotomy, properly performed, has failed.

WHAT DOES A TEST OF VISUAL ACUITY MEASURE?*

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One need not proceed far in the study of psychology before realizing forcibly the freedom with which psychology has utilized the experimental and clinical observations made in medicine. This is true in every field, but particularly in psychiatry. The fact is so obvious that it can be dismissed without further emphasis. It is equally clear, at least to the psychologist, that the medical profession has been content to go on serenely indifferent to a great deal of useful and sound data established by experimental psychology—data determined by a technic of experiment so rigid that it satisfies all the best canons of scientific research. This indifference, though of considerable cost, at least to the more theoretical aspects of medicine, is easy to understand. One reason that naturally occurs is that much of the work in psychology, especially in connection with the so-called higher processes, must, because of its nature and the present state of incomplete knowledge, be vague, philosophic and, therefore, generally abhorrent to those concerned with the tangible facts of medicine. This branch of psychology cannot appeal strongly to a medical technologist because at best it deals with processes which are less understood than dimly sensed, and which reveal no immediately corresponding anatomic or physiologic correlate with which the medical profession can begin to work.

The physician is rightly preoccupied with the material aspects of the organism, and therefore perhaps properly distrusts and ignores a science which offers so much that is vaporous and intangible and occupies itself so frequently with speculative constructions. In doing so he has, however, made the costly error of casting all psychologic work in this one category, and has failed to make valid use of an important and solid body of observations of a different nature—observations which are of a scientific purity and soundness unexcelled even by the very best physiologic investigations. No one will have the temerity to make the assertion that the incorporation of these observations will be of great practical value to medicine, although that too is not unreasonable. At least it can be safely said that they will have a value to medical theory and will force definition and clarification of some of the conceptions which are equivocal and vague, and which, because they are accepted

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without a realization of the problems involved, are the more dangerous, being employed as if they really represented a definitely established fact. The contribution of psychology to the problem of visual acuity belongs to the class that can be profitably examined by the medical profession. Recognition does not necessarily demand that a change in the method of testing visual acuity must follow, although that too may be neither impossible nor undesirable, but at least it will show the physician what the results of his test may or may not signify. At any rate, it will shake his confidence in it as a definite measure of a presumably constant characteristic. If nothing more, it will demonstrate the enormous complication of a function on which a fictitious, though perhaps practically useful, simplicity, has been conferred. It will necessarily lead to a theoretical comprehension of the true inwardness and character of the varied problems involved and a recognition of practical errors to which the medical profession is at present innocently indifferent.

To begin with, what is the current medical conception of visual acuity, the manner in which it should be measured and the meaning of the quantitative results obtained? The exposition in de Schweinitz'[1] standard work is typical, and some of the statements are representative of what the medical profession accepts in regard to the subject of visual acuity. The following is quoted directly (pages 34, 35, 68 and 69):

Visual Angle.—The apparent size of an object depends upon the size of the visual angle. . . . The figure shows that the object, in order to subtend the same angle, must be larger the farther it is removed from the eye. The letter *A*, seen clearly at 6 meters, would have to be three times as large in order to be seen distinctly at 18 meters, and ten times as large in order to be seen clearly at 60 meters. The visual angle in three instances remains the same. Visual Acuteness; Limit of Perception.—An object 1 cm. in size, placed 1 meter distant from the normal emmetropic eye is plainly visible. If this object is moved farther and farther away, it forms a progressively smaller visual angle, until a point is reached beyond which it cannot be perceived, owing to the diminutive size of the visual angle. The limit of perception has now been reached. The angle which the object subtends at this distance from the eye represents the maximum acuteness of vision. An object twice the size would be seen distinctly at twice this distance. An object one-half the size could not be distinctly seen at more than half this distance. In general terms the size of the object denoting the acuteness of vision is always proportional to the distance. . . . Visual acuteness. . . . is influenced by other visual factors, namely the transparency of the ocular refractive media, the refraction of the eye and the condition of the retina and optic vision. . . . It is usual to express these results (of testing acuity with Snellen or other test-types) according to the formula $V = \frac{d}{D}$, in which *V* stands for visual acuteness, *d* for the distance of the patient from the card, and *D* for the distance at which the type should be read.

1. De Schweinitz, G. E.: Diseases of the Eye, Philadelphia, W. B. Saunders Company, 1924.

The first statement in this quotation is a significant error, and although but indirectly related to the immediate subject of this paper, must be gone into for the cue it might give to reasons for the misconceptions and inadequate representation of acuity in medicine. In saying that the apparent size of an object depends on the size of the visual angle, de Schweinitz has, apparently unwittingly, stepped into one of the most persistent and troublesome problems in psychology. The problem is much too involved to be treated here and would carry one too far afield. A cursory inspection of the psychologic treatment of the subject in a book like Fröbes, or even in Nagel's "Handbuch der Physiologie," will show that it can be said without the least trace of dogmatism that de Schweinitz is wrong. Actually, the apparent size of a perceived object depends least of all on the visual angle. The whole difficulty comes in the attempt to determine precisely on what it does depend. Men who have devoted many years and a great deal of work to the problem would hesitate before assigning an even more plausible explanation. A simple observation will show that the visual angle is not the determinant. Taking the same letters that de Schweinitz speaks of, which with an increase in size give the same visual angle when the distance is increased correspondingly, and should according to him possess the same apparent magnitude, one finds that the large objects are, nevertheless, perceived as larger than the small. The patient knows nothing, in his experiencing of the letter, of visual angle; to him the large object is simply perceived as a larger object than the small. This does not, of course, mean that he resolves it better, that his acuity for it is better than for the small. (This question of the relationship of apparent size and acuity will be taken up later and forms the principal subject of this paper.)

As a matter of fact, de Schweinitz' error is gratuitous and rises purely from incautiousness. For his purpose, he can easily avoid the pitfalls here entirely by omitting reference to apparent size altogether, for he is not concerned with it. What he means, and what he can properly state, is that the size of the retinal image depends solely on the visual angle. This is different from saying that the apparent size of the object depends on the visual angle, and, as will appear later, the distinction is also of importance. That retinal image, and not apparent size of object is all that he legitimately may, and actually does, mean, becomes clear from the diagram placed immediately below his erroneous assertion on page 34. It shows three letters having a relation of 6:18:60, with a corresponding relation of distance of each letter from the eye, so that the visual angle, and hence the retinal image, is identical for all three. In fact, all three letters are included between two lines of projection which pass from the extremities of the letters through the nodal point, and, after intersecting, continue to the retina where they subtend one

given arc, that is, give for all three letters an image identical in retinal position and magnitude.

It is to be feared that to the medical man this insistence that the visual angle be spoken of as determining only the size of the retinal image, and not the apparent size of the object, will appear like the futile quibbling of pedantry. But it is far from that; first, it is an admonition to caution in carrying statements no farther than the empiric facts warrant, and this certainly is harmonious with the practice of any science. But there is a far more urgent reason for the insistence. De Schweinitz' transgression arises from the astonishing acceptance by the medical profession of the common sense assumption that what a person sees is the image on his retina. Nothing could be further from truth and observable fact. It will be my purpose in this paper to emphasize the fact that one does not see with the eye, but only through the mediation of the eye; I shall stress particularly the bearing of this fact on visual acuity and the practical interpretation of tests of acuity. To the physician, steeped in positivistic science, this must sound dangerously futile and metaphysical. But if he can so far surmount his aversion as to continue reading, he will find that it represents the observable facts with the utmost descriptive fidelity of science.

The basis of acuity testing in medicine and of the Snellen and other test types is the tacitly assumed doctrine that geometric relationships alone determine and explain visual acuity. That this is not at all in agreement with experimental facts will be shown first by a consideration of acuity in the periphery and then in the fovea.

In 1865, Aubert,[2] a physiologist, discovered the phenomenon, since known as the Aubert-Foerster phenomenon, which administered the first blow to the doctrine referred to in the foregoing paragraph. Working on peripheral acuity, he found that small near complexes can be resolved better and more excentrically than large and correspondingly far complexes. To put it in current terms, the small near complex possessed a decidedly higher degree of acuity, as much as 50 per cent, far beyond the limits of experimental error. And this despite the fact that illumination for both sizes was the same and the geometric relationships between figures and distances of observation were designed to give precisely identical visual angles and retinal images. To translate this in terms of foveal acuity, it means the same as if a Snellen letter of size 1 at 6 meters could be resolved, while another of size 10 at 60 meters could not be, but had to be brought to a distance of 30 meters to be equally well resolved. (It is to be noted that this is only an interpretation in terms of central vision and does not represent the actual difference in central vision. As will be shown later, a similar, but less pronounced, inconsistency obtains in the fovea.)

2. Aubert, H.: Physiologie der Netzhaut, Breslau, 1865, pp. 235-253.

Heinrich [3] attempted to explain this incongruity on the grounds of a presumable idiosyncrasy of the lens, which when thicker for near accommodation projected clearer images peripherally than when thinner for distant accommodation. He thus wished to demonstrate that here the problem was really not one of a difference in acuity, but primarily of a difference in the behavior of the physical dioptric apparatus of the eye, more particularly in this case, of the lens.[4]

Jaensch [5] repeated Aubert's work, but at the same time undertook to test Heinrich's explanation of the phenomenon. Heinrich laid it to the thinness of the lens for distant and thickness for near accommodation. If, therefore, Jaensch argued, the lens were kept constant by some artificial means, and Heinrich's contention were correct, the Aubert-Foerster phenomenon should be eliminated, and the two sets of complexes should be equally well resolved and show the same degree of acuity. In the experiment, Jaensch obtained this constancy of eye lens by allowing observation at the greater distance with the bare eye, and at the smaller distance with a properly chosen convex glass lens placed before the eye. The eye lens was, thus, kept equally thin in both cases. But the Aubert-Foerster phenomenon reappeared in full strength. The amount of difference in acuity between the two complexes remained undiminished by the interposition of the glass lens, in the case of every observer. Experimentally, Jaensch's work in this regard is beyond reproach, for only if he had succeeded in substantiating Heinrich, could it have been argued that the small complex had lost its former advantage because of reduced illumination of the image resulting from reflection and absorption of light in the glass. Here it retained its advantage despite such handicaps. Against the argument that the lens was perhaps inadequate to making the eye lens exactly as thin as when accommodated at the greater distance, the answer can be made that if the eye lens were thinned at all, even if only inadequately, there should have been at least a reduction of the phenomenon in some observers, and this there was not in any degree.[6]

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3. Heinrich, W.: Die Aufmerksamkeit und die Funktion der Sinnesorgane, 2 Beitrag, Ztschr. f. Psychol., 1896, vol. 11.

4. For a full treatment of the relationship between acuity and the ocular apparatus see Ellis Freeman: Untersuchungen über das Indirekte Sehen, Ztschr. f. Psychol., July, 1929; also The Anomalies of Peripheral Visual Acuity, J. Exper. Psychol., August, 1929.

5. Jaensch, E. R.: Zur Analyse der Gesichtswahrnehmungen, Ztschr. f. Psychol., 1909, Ergänzungsband 4, pp. 1-140.

6. Just as Heinrich had an explanation based on the mechanics of the eye, so Jaensch has an equally unacceptable psychologic explanation based on an unsatisfactory and primitive notion of attention. This need not be gone into here, for I am concerned only with his strictly objective experimental observation about which there is no question. They have been repeatedly substantiated.

The search for an explanation of this astonishing incongruity which constitutes the Aubert-Foerster phenomenon possessed a perennial fascination for physiologists and psychologists. A great deal of work was done toward the discovery of its causes, but nothing much came of it.[7] One has only the objective fact that it is there as a phenomenon with which to be reckoned.

In the psychologic laboratory at Frankfurt am Main [8] the problem was again attacked, but this time not to find the determinants of the phenomenon, but rather to discover if it were, as asserted by Jaensch and others,[9] a basic and universal manifestation of vision under all conditions. It seemed advisable to determine if it were not rather purely a function of the method of investigation employed. If it were demonstrated as only a function of method, the contention of its universality under all conditions of vision would be shaken, and it would then be known that experimental conditions could be devised where it did not appear. But in any case, the Aubert-Foerster phenomenon would still remain an inexplicable incongruity which appeared under certain special conditions, rather than, as was thought, under all conceivable conditions. To this end it was necessary to devise a method different from all preceding ones of testing peripheral acuity.[7] In order to avoid distraction from the main interest of this paper, the details of the old and of the newly devised method will be omitted. It will suffice to say that both were adequate but different in principle. The older method, that of Aubert and of Jaensch, took the complex and moved it from the fixation point to that position on the campimeter where its parts just ceased to be resolved. (Variations were also employed, but in principle the procedure was identical.) Thus the measure of acuity was directly the distance from the fixation point to the peripheral position where the resolution ceased. At Frankfurt, the new method consisted of placing both figures (two black squares, for instance) forming the complex to be resolved at a selected point in the periphery, that is, at a chosen distance from the fixation point. By means of an appropriate mechanical device, the white space or interval between the two black squares was gradually increased from zero until resolution occurred, that is, until the two black squares were distinguished as two surfaces and not fused as one. In this case

7. For a full account of the work done see Ellis Freeman (footnote 4, first reference).

8. Freeman, Ellis: Untersuchungen über das indirekte Sehen, Ztschr. f. Psychol., August, 1929.

9. Jaensch (footnote 5). Jacobsson, Malte: Ueber die Erkennbarkeit optischer Figuren bei gleichem Netzhautbild und verschiedener scheinbarer Grösse, Ztschr. f. Psychol., 1916, vol. 77. Jaensch, E. R., and Schönheinz, Wilhelmine: Einige allgemeinere Fragen der Wahrnehmungslehre, Arch. f. Psychol., vol. 46. Kaila, Eino: Eine neue Theorie des Aubert-Foersterschen Phänomens, Ztschr. f. Psychol., 1921, vol. 86.

the acuity was inverse to the width of the white interval needed for resolution. This means, naturally, that when one complex required a proportionately smaller interval for resolution, the acuity for that complex was greater.

What is important to the present argument is that this work at Frankfurt not only eliminated the Aubert-Foerster phenomenon, and demonstrated, therefore, that it was a function of the method formerly employed, but in turn unexpectedly revealed a new phenomenon, which was no less a function of the new method employed. It consisted of an enormously higher degree of acuity for the large complex than for the small (as high as 80 per cent greater in many cases), which was a complete reversal of the Aubert-Foerster phenomenon. A situation in foveal vision which would correspond to this (and this is not to be taken as a declaration that such a corresponding situation exists in foveal vision) would be that in which a Snellen letter of size 1 could be resolved at 6 meters, while another of size 10 could be resolved at about 100 meters, instead of 60.

The Aubert-Foerster phenomenon and this new one of opposite character are objective facts determined by adequate experimental work, and must be recognized however inadequate any physical explanation which is attempted may be. In fact, the difficulty of finding a physical explanation lies in just this: that whatever seems to account for the one is contradicted by the other phenomenon. It may be objected that this concerns the periphery, and, while strange and interesting, has no bearing on the subject of foveal acuity with which medicine is more immediately occupied when dealing with acuity. It has just this much bearing in that it shows that in the periphery at least any notion that acuity depends solely on the visual angle (see de Schweinitz' quotation on visual acuteness) is as untenable as that apparent size of objects depends solely on the visual angle. If acuity in the periphery were determined solely by the visual angle, then there ought be no Aubert-Foerster phenomenon or the opposite one, since in both methods the visual angle is identical for the large and the small complex. As will appear in the experimental work that follows here, the visual angle is no more the determinant of acuity in the fovea than in the periphery.

Jacobsson,[10] working with extreme care and employing letters of various sizes, determined the limits at which they could be resolved, and found in foveal vision that the size of the letter was not proportional to the distance at which it could be resolved, in other words, that the visual angle does not determine acuity, as is assumed by those who test with Snellen charts. He found a condition parallel to that of the Aubert-Foerster phenomenon. His data show distinctly that, just as in the

10. Jacobsson (footnote 9, second reference).

periphery, in the fovea large distant letters require a greater visual angle for resolution than do small near letters. Similarly, Wanda von Lempicka,[11] working at Göttingen, found that a group of alternating large gray and white stripes require a greater visual angle for resolution than do correspondingly small and near stripes.

This amazing complexity is further increased by recent observations made in the Cornell laboratories in connection with an investigation concerning color perception. (The entire work is not complete, but that part having a bearing on the present discussion is ready, and may therefore be cited.) It has been shown that in the recognition of the hues of various sized surfaces the smaller areas have an advantage over the large ones in acuity; that is, they demand a smaller visual angle, and indeed a decidedly smaller one, in order to permit the recognition of hue. This is true of reflected light under outdoor conditions as well as of transmitted light in a dark room.

The natural question then arises, Which method measures acuity in the periphery? What should be a method of measuring acuity in the fovea? Is the proper method for the periphery that of Aubert or that of Frankfurt? And having chosen one method, shall the results with the small near complex be taken as that measure, or those with the large and correspondingly distant complex? The two give contradictory results! As to measuring acuity in the fovea, what shall be the proper method? Certainly the present purely geometric method based on a falsely assumed simplicity of relationships that are constructed purely on geometric logic does not designate acuity. Enough has been said to show that with the use of Snellen's and similar charts one can only say that if the patient resolves the figures of all sizes customarily employed at their proper distances, the limit of his resolving power has not been reached. If his limit is reached with one size, a large size, it must logically follow on the basis of commonly accepted geometric optics that his limit has been reached with the correspondingly small one at the correspondingly shorter distance. The work of Jacobsson and others on foveal acuity has shown that this geometric inference is false.

Now suppose it were necessary to determine the acuity of a patient's foveal vision to a degree of accuracy ordinarily unsought and unnecessary for the correction of common abnormalities of refraction. (The present Snellen method may be, and as far as I am qualified to say, probably is, wholly adequate for the ordinary needs of medicine. But that is not the question.) And suppose further that the physician agreed that the geometric method of considering only the visual angle, as in the use of the Snellen charts, was inappropriate, and that he agreed to employ the method of the limit of perception as used by Jacobsson and

11. Lempicka, Wanda von: Räumliche Farbenmischung auf der Netzhaut, Ztschr. f. Sinnesphysiol., 1918, vol. 30, part II.

the others mentioned. He would then get a series of progressively increasing visual angles as he chose larger figures. What would these angles then mean as measures of acuity? Which letter would properly represent the patient's acuity, the one he resolved at 5 meters or the one at 50 or 100? They would all give results widely at variance with the inferences from geometry and size of visual angle.

These are problems which, if unimportant to the practical ophthalmologist, are of the utmost importance to the medical scientist, the physiologist, who is not harassed by the insistence of a suffering patient demanding relief and not sound science. To recognize them as problems is to become liberated from the trammels of the one attitude which has prevailed in optics, namely, that of geometry, and perhaps to prepare the way to a juster description of the facts which have been obscured by that attitude.

SPONTANEOUS NYSTAGMUS

SOME PRACTICAL CLINICAL FEATURES, ESPECIALLY ITS OCCURRENCE WITH DIPLOPIA*

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The involuntary rhythmic oscillations of the eyeballs, the nystagmic movements, are in reality defensive reactions of the ocular muscles in the interest of ocular fixation and orientation in space. Normal function of these muscles, that is, the ability to fix on a given object, depends on calculated correct movements and on the ability, after bringing the object into the line of the fovea centralis of both eyes, to keep it there for the necessary period, an act accomplished by normal tonus. The production of these movements and the necessary tonus depends, on the one hand, on voluntary innervation and, on the other, on certain reflex phenomena, the afferent arm of which is initiated principally in the retina and in the labyrinth (Stellungapparat and Blickapparat [1]). Any factors clinicopathologically or experimentally induced by interference with visual fixation or labyrinthine function as well as with the posterior longitudinal bundle may produce nystagmus. Based on these conceptions of origin, nystagmus may be ocular, otologic or neurologic. Spontaneous nystagmus only will be considered.

Nystagmus being an important clinical sign, every available method for its investigation is of significance. While it is true that the nature of nystagmus in the majority of cases can be determined by inspection, it is equally true that even experienced clinicians after a thorough investigation are at times in serious doubt as to the nature and especially as to the origin of the sign. An appreciation of the origin of the sign usually not only determines the diagnosis, but also assists in formulating the prognosis and the treatment. One of us has observed an experienced otologist make a diagnosis of brain stem nystagmus in a case in which an operation was performed for disease of the middle ear, rendering the prognosis unfavorable. An examination by an oculist disclosed

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1. Cords, Richard: Die Ergebnisse der neueren Nystagmusforschung, Zentralbl. f. d. ges. Ophth. u. i. Grenzgeb., 1923, vol. 9.

a typically ocular nystagmus of many years' duration, with a congenital amblyopia.

The sign is of interest to at least three kinds of specialists: the neurologist, who sees it in a multitude of conditions; the ophthalmologist, who may find it to be of ocular origin, thus rendering the prognosis more favorable; and, lastly and most important, to the otologist who is not only the final judge as to the underlying pathologic process and localization of this ocular sign, but the one who most frequently has to decide as to the advisability of surgical intervention.

The purpose in this paper is to present some practical clinical points for the accurate determination of the nature of spontaneous nystagmus and to point out the fairly common and important relationship of the latter to diplopia. It is not our intention to discuss experimental nystagmus nor the various time-consuming examinations which so often are difficult to carry out.

The presentation is based on combined neurologic, ophthalmologic and otologic investigations of large numbers of cases in the otologic clinic of Prof. Gustave Alexander of the Polyclinic Hospital and in the eye clinic of Professor Sachs of the Widener Krankenhaus of Vienna.

METHODS OF INVESTIGATION

For practical purposes, spontaneous nystagmus is divisible into neurologic,otologic and ocular, a classification which discloses its basic origin and hence its importance for clinical purposes. (Endstellung nystagmus is probably a type in itself.) Most ophthalmologists know the common type of the transient otologic nystagmus and that of the more permanent nystagmus of the central vestibular component and its connections with the brain stem. We feel confident, on the other hand, that some of us may not be aware of the appalling frequency of purely ocular nystagmus, the existence of which tends to modify and often to complicate clinical estimations. Nevertheless, there is a single brief method, which is easily carried out in the office or at the bedside which makes the localization of spontaneous nystagmus possible on inspection in the great majority of cases. The method is employed in Professor Alexander's clinic, and consists of making the following observations concerning the nystagmus: (1) Type. Is it horizontal, rotatory, vertical or a combination of these types? The useful information obtained by making this determination is that a pure nystagmus, horizontal, rotatory or vertical, speaks against labyrinthine involvement and usually indicates a lesion in the brain stem (arcuate fibers of vestibuloris or fasciculus longitudinalis posterior), whereas a horizontal rotatory nystagmus is usually of peripheral labyrinthine origin. (2) Direction. This refers to the direction of the quick component of the nystagmus to the right or left. It may not be directed. In that case, it

is called undulating and is usually of ocular origin. (3) Degree. This refers to the direction in relation to the eyeball and for useful clinical purposes is divisible into three degrees. In the first degree, a spontaneous nystagmus is present when the eye is turned in the direction of the quick component. Thus, when the patient looks to the left, the quick component is directed to the left; when he looks straight ahead there is no nystagmus. It is spoken of as a nystagmus of first degree to both sides if when the patient looks to the right, nystagmus develops to the right, and when he looks to the left, nystagmus develops to the left. Endstellung nystagmus is of the first degree. The second degree is present when the patients looks straight to the front. In the third degree, which is the most important, the nystagmus occurs opposite to the direction in which the patient looks. For instance, when the patient looks to the left he has a nystagmus to the right. The first and second degree may be of any origin, whereas the third degree indicates a lesion of either the brain stem or the vestibular apparatus. (4) Frequency. The jerks may be of slow, medium or high frequency. The extremes of frequency are usually of ocular origin, whereas medium frequency occurs in peripheral labyrinthine and in central nystagmus. (5) Amplitude. This may be small, medium or large. Extremes of amplitude are of ocular origin, while medium amplitude is of peripheral labyrinthine or of central origin. (6) Associated or disassociated nystagmus. Whether or not the eyes move simultaneously in the same direction at the same speed should be noted. The practical information obtained is that disassociated nystagmus is always of ocular origin. (7) Permanency. The duration of nystagmus may be from a few seconds to a lifetime. Nystagmus of brief duration is usually labyrinthine, whereas ocular nystagmus develops in early infancy and lasts throughout life. Changeability indicates central nystagmus and is of great importance.

This enumeration would seem, at first sight, to render the subject complicated. A little practice, however, makes the examination simple and brief, while experience with it proves its usefulness (cases 1 and 2).

Table 1 shows the characteristics of nystagmus from the standpoint of the three types of the condition, while table 2 shows other clinical features associated with each of the three types.

In the majority of cases the scheme of examination already outlined is fairly conclusive for practical clinical purposes, especially if combined with a good history. If not conclusive, one has to resort to the more complicated and time-consuming examinations which include the evaluation of the cochlear component of the inner ear, caloric, turning, galvanic and mechanical tests of the vestibular component, and the optical tests, and, of course, to a neurologic study. It may be worth while for the completeness of a differential diagnosis to recall that peripheral labyrinthine nystagmus and central nystagmus are suppressible by experimental

nystagmus and induced by turning, douching or optical methods, while ocular nystagmus frequently remains uninfluenced by all these procedures (Sommer,[2] Köllner[3]). In this connection, the existence of double vision (diplopia) may be of some importance, and it is our intention to stress this point briefly.

TABLE 1.—*Characteristics of the Three Types of Spontaneous Nystagmus*

Type	Nystagmus	Direction	Degree	Frequency	Amplitude	Association	Duration
I	Peripheral labyrinthine	Directed to one side, usually to the side of the nonaffected ear	I, III	Medium	Medium	Associated	From seconds to weeks
II	Central labyrinthine (often pure)	Directed to one side, often to the side of the lesion in the brain	I, III	Medium	Medium	Associated	From weeks to years
III	Ocular (all types)	Directed often to both sides, or undulating	I, II	Slow to highest frequency	Largest to smallest excursion	Associated or disassociated	Life

TABLE 2.—*Associated Clinical Data in the Three Types of Spontaneous Nystagmus*

Type	Spontaneous Nystagmus	Ear	Eye	Brain	Experimental Labyrinthine Nystagmus	Experimental Optic Nystagmus	Diplopia	Other Accompanying Symptoms
I	Peripheral labyrinthine nystagmus	Increase, diminution or loss of vestibular irritability	Normal	Normal	Spontaneous nystagmus, suppressed	Typical	Not present	Turning dizziness typical falling and postfalling
II	Central labyrinth	Normal	Normal	Involvement of the cranial nerves especially the seventh and of the descending motor tracts	Spontaneous nystagmus, suppressed	Typical	May be present	Depends on extent of lesion
III	Ocular	Normal	Anatomic defects and pathologic lesions of cornea iris, lens, choroid and retina; concomitant squint, night blindness, albinism, etc.	Normal condition, idiocy or imbecility	Spontaneous nystagmus, difficult to suppress	Spontaneous nystagmus, difficult to suppress	Not present	Not present

2. Sommer, J.: Ueber das Verlaufen des Spontaneous Nystagmus bei Anwendung Optischer und labyrinthischer Reise, Monatschr. f. Ohrenh. **58**:606, 1924.

3. Köllner: Ueber die Bedeutung des vestibular und des optischen (Eisenbahn) Nystagmus für die Diagnose des spontaneous Nystagmus, Arch. f. Augenh. **92**:219, 1923.

NYSTAGMUS AND DIPLOPIA

That nystagmus itself can produce diplopia independent of any cause for the latter was known by Urbantschich [4] and Bartels.[5] They found diplopia in experimental nystagmus after douching the ear and in fistula syndromes. Bartels explained the condition by the stronger innervation of the homolateral eye which resulted in a squint and diplopia. The occurrence of diplopia in experimental nystagmus has not been confirmed by one of us (I.S.[6]). Furthermore, diplopia is absent in peripheral labyrinthine nystagmus. The reason for this becomes apparent when we consider the possible causes of diplopia in nystagmus, in general, from another angle.

The object, indistinct during nystagmus, must have its image incident to the fovea for clearest vision. This is necessitated by fusion and cerebration. Because the eye must wander, the retina get the clearest impressions only at the two extreme ends, while the intervening images are blurred or suppressed; that is, the double images are situated at the extreme ends.

It is therefore apparent that in peripheral labyrinthine nystagmus, in which there is an overwhelming confusing movement of the surroundings, clear orientation and, hence, fixation, are impossible; in other words, the dizziness accompanying peripheral labyrinthine nystagmus displaces the diplopia. It is fairly well established that peripheral labyrinthine nystagmus does not occur without dizziness, though the latter may occur without nystagmus.

The absence of diplopia in ocular nystagmus may be explained in the same way. Ocular nystagmus is usually acquired early, within the first two years of life, while the child is learning the process of fixation and fusion. It remains permanent, comparable perhaps to associated movements. If there ever was any diplopia, none can be recalled. Not infrequently a trembling movement of the surroundings may be experienced in later life. Less occasionally, one finds nystagmus with amblyopia when the high degree of amblyopia in the one eye is accompanied by a squint and with suppression of one image. Miner's nystagmus, an acquired type, is unaccompanied by diplopia.

From what has been stated, it would seem that spontaneous nystagmus of any origin interferes with the proper fixation of the image, making fixation possible only at the extreme ends of the excursions of the eyeballs, a position which should result in diplopia. In the acute cases, which are usually of labyrinthine origin, there is an associated

4. Urbantschich.: Ueber die Beeinflussing subjectiver Gesichtsempfindungen, Arch. f. d. ges. Physiol., 1903, vol. 94.

5. Bartels: Ueber die Regulierung der Augenstellung durch den Ohrapparat, Arch. f. Ophth. **76**:1, 1910; **77**:531, 1910.

6. Sommer, I.: Labyrinth und Schielen, Ztschr. f. Augenh. **65**:14, 1928.

dizziness and spatial disorientation which prevents diplopia. The same is true of central nystagmus, in which there is associated dizziness. Cases of ocular nystagmus are not acute; the condition commences early in childhood before fixation, as such, has been acquired, and is not infrequently associated with amblyopia. If the nonoccurrence of diplopia is assumed in acute labyrinthine and ocular spontaneous nystagmus, there remains central nystagmus in the acute stages in which there is no accompanying dizziness and that in chronic forms in which the patient has not yet learned how to suppress one image. The occurrence of spontaneous nystagmus with diplopia, therefore, should direct attention to the central nervous system.

Of twenty cases of central nystagmus examined by us, almost one-half had diplopia. The search of the literature on the subject proved futile so far as the causation of the diplopia was concerned, except, of course, in those cases in which there was a coexisting involvement of the extra-ocular muscles; for example, in lesions of the posterior longitudinal bundle, where, within a small central area, both coordinative and nuclear centers are located.

The importance of this occurrence of nystagmus with diplopia becomes apparent also from another angle, when it is recalled that some patients (cases 6 and 7) came to the hospital complaining only of diplopia with no symptoms referable to the central nervous system and unaware of the nystagmus, and in whom examination failed to reveal a paresis of the muscles. The condition may be the earliest subjective hint of disease of the central nervous system.

SUMMARY

1. A simple and rapid method is described, practical in everyday practice and capable of determining the nature and origin of spontaneous nystagmus.

2. Particular attention is directed to the frequency of ocular nystagmus.

3. The nature of diplopia occurring with nystagmus is discussed.

4. Diplopia with nystagmus, independent of paresis of the extra-ocular muscles, usually points to disease of the central nervous system.

5. A summary of illustrative cases is appended, grouped in the following order: pure ocular nystagmus (cases 1, 2, 3 and 4), pure neurologic nystagmus (cases 6, 7 and 8), pure labyrinthine nystagmus (cases 9 and 10) and combined ocular and neurologic nystagmus (case 5).

REPORT OF CASES

CASE 1.—K. A., a boy, aged 7, had had typical ocular nystagmus since early childhood. The reaction to the usual optical test was a normal vestibular response. The condition was caused by marked amblyopia without anatomic observations.

The family history was negative. The mother observed jerkings of the eyes in early infancy. Vision in each eye was 20/80. The results of external and ophthalmoscopic examinations were negative. Skioscopic examination revealed ametropia of low degree. The results of neurologic examination were negative except for the finding of nystagmus, which was: (1) associated, (2) horizontal, (3) undulating, (4) second degree, (5) of medium frequency, (6) small amplitude and (7) permanent. There was no diplopia. Perception of colors was normal. An otologic examination revealed a retracted ear drum on the right side and perforation on the left. A whispered voice was heard at a distance of 4 meters on the left side and of 6 meters on the right side. Tuning fork tests showed a lesion of the middle ear. In vestibular tests, cold water in the right ear did not influence spontaneous nystagmus, but there was typical falling and dizziness. Optical tests showed inversion.

Case 2.—M. F., a boy, aged 10 years, showed color blindness and ocular nystagmus but no diplopia.

According to the mother, the jerking of the eyes had been observed since early infancy. Vision was 20/60 in each eye. The eyes, which were normal, showed color blindness for yellow and blue. The spontaneous nystagmus present was: (1) associated, (2) horizontal, (3) second degree, (4) of medium frequency, (5) small amplitude and (6) permanent. The cochlear component was normal. In examining the vestibular component, spontaneous nystagmus was not changed after syringing the ear; optically it was inverted; that is, the direction of nystagmus was uninfluenced.

Case 3.—S. F., a man, aged 53, gave a history of eye jerkings since childhood. Typical ocular nystagmus was present; a diagnosis of multiple sclerosis was considered.

Because of some symptoms of the stomach, a diagnosis of multiple sclerosis was made. Vision, eyegrounds and fields were normal. Spontaneous nystagmus was present as in case 1. The cochlear component showed evidences of otosclerosis. In a test of the vestibular component, douching increased the nystagmus; the nystagmus was uninfluenced by the optical tests.

Case 4.—F. F., a man, aged 26, single, presented a case of latent ocular nystagmus; jerkings of the eyes had occurred since early childhood. Vision was: monocular, right, 20/40, left, 20/80; binocular, 20/40. There was a converging squint of the left eye. When one eye was covered, nystagmus appeared in the uncovered eye; it was horizontal, of medium frequency, and directed toward the open eye. There was no diplopia. The fields of vision were normal. The cochlear component was normal. In testing the vestibular component, douching caused the normal syringing response; after covering one eye, however, the spontaneous nystagmus recurred. Results of the optical test were: binocular, against the direction of turning, and monocular, in the direction of turning.

Case 5.—B. I., a boy, aged 17 years, had showed a squint of the right eye in early childhood; no dizziness had occurred at any time. Chronic otitis, diplopia and nystagmus had been present since childhood. The diplopia was caused by paresis of the extra-ocular muscles; this also caused the nystagmus. An intracranial otologic condition was considered because of nystagmus and diplopia. Vision was: right, 20/80, and left, 20/20. The eyegrounds and the perimetric fields were normal; the right eye was in exotropia. Testing revealed paresis of the right external rectus and of the inferior rectus with uncertainty about the superior rectus and the inferior oblique. In a test of the nystagmus, the eyes, when looking straight out, made horizontal rotatory jerks to the right; when

looking to the right, the jerks became greater, and when looking to the left there were medium amplitude and frequency. In the right ear, there was a chronic adhesive process; a whisper was heard at a distance of 5 meters. The left ear showed chronic suppuration; a whisper was heard at 3 meters. Syringing the right ear with cold water induced spontaneous nystagmus of second degree to the left; syringing the left ear, spontaneous nystagmus of third degree to the right. Neurologic examinations otherwise gave negative results.

CASE 6.—S. H., a woman, aged 28, appeared at the clinic because of diplopia, blurring of vision and difficulty in getting about. There was no extra-ocular cause for the diplopia; the latter was undoubtedly caused by the nystagmus. It was the earliest subjective sign in this case of multiple sclerosis. The condition was of several weeks' duration. Vision, eyegrounds and fields were normal. Testing of the muscles of the eye revealed diplopia, but no paresis of the muscles. Tests of the spontaneous nystagmus showed: when the eyes were looking straight ahead, nystagmus to the left; when looking to the right, nystagmus to the right, and when looking to the left, nystagmus of first and second degree to the left. The cochlear component was normal. Tests of the vestibular component showed: in syringing of the right ear, a horizontal rotatory movement of the third degree to the left, and in syringing of the left ear, a horizontal rotatory movement of the third degree to the right. In the optical test, the direction was against the direction of turning. Neurologic examination in Prof. Wagner Jauregg's clinic revealed the existence of multiple sclerosis.

CASE 7.—G. A., a trained nurse, aged 25, reported diplopia, and dizziness on turning to the left, of two weeks' duration. There was no headache. The patient was attending a patient who had multiple sclerosis when she developed the dizziness and diplopia. The results of objective examination were negative except for spontaneous nystagmus of central origin and convergence on douching, a condition which was functional. Vision, eyegrounds and perimetry were normal, and tests of the eye muscles gave negative results. Spontaneous nystagmus was: associated, horizontal, to the right, of second degree, medium frequency and amplitude and of considerable duration. The cochlear component was normal. In tests of the component, vestibular douching of the right ear with cold water produced horizontal rotatory nystagmus to the left; douching of the left ear, the same type of nystagmus to the right. Syringing of the left ear was followed by a spasm of the eyeball inward (a sign of functional disease). A neurologic examination gave negative results except that the patient inclined to the left when walking. All other investigations gave negative results.

In a few months, examination showed nystagmus only in the end position, but a convergence nystagmus was still present. Diplopia had disappeared in a few weeks. Two years later the intention tremors, ataxia, absence of abdominal reflexes, etc., of a fully developed multiple sclerosis were present. This condition was uninfluenced by malarial treatment. The nystagmus had almost disappeared, but on looking to the extreme right there was still diplopia. The visual field of the right eye at this time was considerably contracted. The existence of an early, multiple sclerosis with hysteria was based correctly on the early observation of nystagmus.

CASE 8.—D. B., a woman, aged 36, complained of dizziness and double vision when looking down. It was a case of recurrent vertical nystagmus with diplopia in a syphilitic lesion of the fasciculus longitudinalis posterior. This condition recurred at intervals for two years. Vision, visual fields and eyegrounds were normal. The diplopia was not associated with lagging in the lamp test; that is,

no actual paresis was present. Spontaneous nystagmus was associated, vertical, and of medium frequency and amplitude. The cochlear component was normal. Vestibular experimental nystagmus gave normal responses. Neurologic examination gave negative results, but the Wassermann reaction was positive. The patient improved under antisyphilitic treatment. The lesion was localized in the oral part of the fasciculus longitudinalis posterior.

CASE 9.—S. A., a woman, aged 36, was referred by the gynecologic department with a diagnosis of chronic parametritis following childbirth.

There was an acute, toxic vestibular neuritis, the infection resulting from a pelvic lesion. The patient had complained, for the previous few days, of attacks of turning dizziness, especially in stooping, of vomiting and of movement of the surroundings. She had never had a similar attack before. Vision, eyegrounds and fields were normal. There was no diplopia. Spontaneous nystagmus when she looked to the right was rotatory, of first degree, medium frequency and amplitude and was permanent; when she looked to the left, the nystagmus was horizontal, rotatory and of second degree, but was otherwise the same as on the opposite side. Spontaneous falling occurred to the right, and there was past-pointing with the left arm to the right, that is, in the direction of the slow component. The cochlear component was intact. In the experimental vestibular test, syringing of the right ear with cold water increased the spontaneous nystagmus with typical falling and past-pointing; moderate turning dizziness was present. Syringing of the left ear induced nystagmus of third degree to the right, horizontal, rotatory falling and past-pointing to the left with severe turning dizziness; the spontaneous nystagmus was increased. The neurologic examination gave negative results.

CASE 10.—C. M., a woman, aged 36, had developed impaired hearing in the right ear, attacks of tinnitus aurium, with turning dizziness and vomiting, during the two weeks before examination. This patient presented Ménière's syndrome, most probably due to nicotine; multiple sclerosis was also considered. Typical labyrinthine nystagmus was present. The patient had smoked to excess for years. Vision, eyegrounds and visual fields were normal; there was no diplopia. Spontaneous nystagmus was: horizontal, rotatory, of third degree to the left, with falling to the right and past-pointing to the right. Tests of the cochlear component showed the left ear to be normal, and the right ear to hear a whisper at a distance of one-half meter. On experiment, the right ear was not irritable; that is, there was no change in the nystagmus. Douching of the left ear caused the spontaneous nystagmus to disappear. All other examinations gave negative results.

THE MYOPIC PROBLEM *

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In reference to optic conditions, we possess a clear and precise definition of all the refractive states of the eye which extends back even to the time of Kepler (1611).

Donders discussed the problem thoroughly. The definition being purely physical, it is clearly understood as such. Refractive conditions are divided into three types: the far-sighted, or hyperopia; the near-sighted, or myopia, and between these two the normal, or, as it is correctly named, ideal refraction or emmetropia. In the latter condition, the parallel rays of light unite exactly on the retina after they have been bent by the cornea and elastic lens, thus producing a clear cut image and, consequently, the ideally perfect vision. When these rays are focused behind the retina, the far-sighted condition is present, and when in front of the retina, the near-sighted condition.

In both the last mentioned conditions, an indistinct image is produced on the retina, thus causing a blurring of the sight for distance. In the far-sighted eye, the latter condition is least noticeable in the young, because such patients, by means of accommodation, are able to change the lens to a greatly increased convexity thus enabling themselves to unite these rays on the retina.

The hyperopic eye in its relationship to the optical system is too short; the myopic eye, too long. In most cases of myopia, the axis of the eye is abnormally long and approximately too great for the normal refraction of the optic media (axis myopia); while in a few less frequent cases, which will not at present be brought into discussion, the refractive strength of the optic media is too great in proportion to eyes with an axis of normal length (refractive myopia). In both cases, there is a diminution of vision for distance, which can be improved not by means of accommodation (for that would lead to an increase in the refractive strength of the lens, thus increasing the degree of myopia), but only by means of concave lenses, which, owing to their dispersion of the rays, will minimize the effort of the whole refractive media.

In the investigation as to whether myopia is to be considered a refractive anomaly in contradistinction to normal refraction, one immediately finds oneself in difficulty regarding the nosology of myopia.

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Donders held that hyperopia was due to an arrested development of the eye, since in such cases the normal emmetropic development which is supposed to occur after birth would thus be hindered; i. e., the marked hyperopic condition of the eye which preponderates at birth changes either slowly or, at least, incompletely to the ideal or emmetropic refractive condition. For this reason, Donders held that the myopic eye was a diseased eye.

The ideal refraction, that is, a refractive condition in which parallel rays in completely relaxed accommodation of the eye are united on the retina, is seldom realized. Practically all eyes are hyperopic at birth. Then, with further development, the eye approaches the ideal relationship between the retractive strength and the length of the axis of the eye.

In only about 8 per cent of the entire population is lengthening of the optic axis produced; that is, the eyes become myopic in the course of their development. In the largest number, in fact, a slight degree of hyperopia persists even to old age. In wild animals and the aborigines, also, the prevailing type of refraction is slightly hyperopic.

Therefore, I will not discuss this lack of development in the hyperopic eye further. On the other hand, it seems evident that the hyperopic eye is the most useful type and in one's daily work especially is more to be desired. If one gives the normal eye the highest percentage, then one must recognize the slightly hyperopic as the normal, and the emmetropic as the ideal, refraction.

BIOLOGIC CONSIDERATIONS

Biologically speaking, the length of the axis of an eye varies according to a definite binomial curve (Stiger). According to the latest investigations by Gallus, the binomial curve does not exist in those cases in which there is a high degree of myopia. Furthermore, biologically from the myopic standpoint, one cannot consider small degrees of lengthening of the eyeball as anything more than the result of a disease process, especially when one recognizes the fact that persons with myopia are for this reason placed at a great disadvantage, in that there is no mechanism for adjusting the eye for distant objects as there is in hyperopia. Therefore, the myopic eye must be considered diseased if the same causes which lead to the increase in the length of the axis also produce a distorted and diseased condition of the tunics of the eye, especially in the posterior segment of the eyeball (staphyloma posticum verum, dehiscences in the lamina elastica with secondary growth of the pigment epithelium, macular changes, conus pictures, etc.).

The immediate recognition of myopia as a disease which first develops in the course of the bodily growth was the main reason why

ophthalmologists inquired into its causes, so that they might try to control these evil effects on the body by prophylactic and therapeutic measures. One has to do a tremendous amount of work and use all one's acute mental efforts in order to discover the endogenous and exogenous factors which lead to the origin of myopia. Endogenous as well as outside influences must play an important part in the production of this condition, since experience shows that myopia may develop in the course of a year, and that the number of cases is exceedingly small among those living under the same conditions.

The procedure by which all these pathologic-anatomic changes in myopia lead to an increase in the axis of the eye and changes in the posterior portion of the eyeball is denominated a lengthening process. If one would know the etiology of the diseased myopic eye, as mentioned previously, causes must be found which lead to an extension of the posterior pole of the eyeball and, at the same time, to a lengthening of the axis and the characteristic anatomic changes in the globe itself.

A historical review of the present and ever changing views as to the origin of axial myopia cannot be given in the space of this short article. Therefore, I will group the various existing theories opposite each other and give a critical analysis of each. In order that the opinion of each author regarding the origin of myopia, may be understood, however, the most important place must be given to those views which deal with the pathologic anatomy of myopia.

PATHOLOGY OF MYOPIA

Lengthening of the axis of the eye is a result of a stretching process which leads more especially to a thinning of the sclera and, at the same time, to a bulging of the tunics of the posterior part of the eyeball. One obtains an idea of the degree of stretching, as for example of the retina, in a bulb with a high degree of myopia, if one utilizes the figures arrived at by Hess. According to Hess, that portion of the retina of a normal eye lying behind the equator covers a surface space about 9 sq. cm. This surface space must be increased many square centimeters in a bulb 31 mm. in length, according to the foregoing observation.

With an equal amount of bulging of the whole posterior half of the eyeball or the production of an irregular and circumscribed ectasia (staphyloma verum) on account of which the axis of the eye is lengthened 1 mm., making 3 diopters of myopia, sooner or later there are tears in the lamina elastica with secondary changes in the macula—the black spot of Fuchs, which has also been called retinitis centralis. Likewise, the retraction of the choroid and the pigment epithelium from the temporal rim of the papilla is to be regarded as a result of this stretching.

As a result, an elliptic piece of the sclera can be seen through the transparent retina between the circle of pigment and papillary rim, sometimes embracing the whole optic disk (conus myopicus). On the other hand, undue thinning of the choroid can sometimes be seen on the nasal side of the papillary border.

In the highly myopic eye, the bulk of the muscle of accommodation appears to be placed farther back, as does also the root of the iris. This causes a deepening of the anterior chamber. Furthermore, in the highly myopic eye, the muscle of accommodation is so little used that it may become atrophied from inactivity.

With a stretching of the tunics of the eyeball, the vitreous, as a rule, does not increase proportionately in amount, but the vitreous chamber becomes filled with a compensatory fluid, thus causing the vitreous to appear to be partly fluidified. Secondary contraction of that portion of the vitreous which has grown to the retina in the region of the ora serrata can produce ruptures in the vitreous, thus allowing the fluid to find a way behind the retina. This explains the tendency of the myopic eye toward detachment of the retina, especially when there is a history of slight trauma and even when this condition appears spontaneously.

As a result of these anatomic observations, writers have concluded that they could thus establish the various theories concerning myopia.

HEREDITY

I shall next consider a small group of theories according to which an inherited or acquired condition of some part of the eye plays the chief part in the production of myopia.

At first, the staphyloma was considered the result of an inflammation of the choroid and the conus picture due to a tear without a previous inflammatory disturbance. Schoen held that the changes in the posterior part of the eyeball were to some extent due to scleritis. Now, however, it is known with certainty that an inflammatory process is not the cause of the myopic changes in the eyeball.

Various authors consider myopia a deformity in development, analogous to deformities in the skeleton and blood vessels of the body, such as bow-legs, flatfoot, contracted tendons (Kuschel), etc.

Römer gave the name "scleromalachia" to a disease of the sclera which may be the cause of myopia. Meyerhof was also inclined to accept this theory concerning scleromalachia. He called attention to a distinct weakness of the posterior part of the sclera in the Egyptian race, but not in the sense of a distinct disease. The number of myopes in Egypt, in spite of the lack of education among the lower classes, is just as pronounced as that in the more educated states of Europe. It is especially noticeable that the neighbors of the Egyptians, the Nubians

and the Sudanese, are practically free from myopia. Meyerhof noted the frequent relationship to, and the prevalence of, anemia as a cause for this great resiliency of the sclera.

Argañaraz compared posterior staphyloma to anterior keratoconus and believed that both conditions must be attributed to the inner secretions.

One can by no means be convinced by these and similar theories, which associate the origin of myopia with a lack of supporting tissues, that myopia is congenital or due to disease, improper living, inbreeding, etc.; because such observations must necessarily harmonize with the daily observation that the large majority of persons who are known to suffer from a lack of supporting structure, flatfoot, contracted tendons, enteroptosis, rachitis, muscle relaxation, etc., not only are nonmyopic, but are just as likely to be hyperopic.

Furthermore, these theories do not explain why unilateral myopia is so infrequent if such constitutional diseases produce a sympathetic involvement of the eyes; neither do they explain the frequent disturbance of muscle balance as manifested by latent divergence and other conditions.

EXTERNAL CONDITIONS

Other authors have a tendency to designate as causes of myopia conditions outside the eye. Hassner and Weiss attributed myopia to a short optic nerve which in the movements of convergence exercises a pulling on the posterior pole of the eye. Weiss termed as the "adjustable part" (Abrollungsstück) that portion of the nerve from the optic foramen to the posterior part of the scleral surface. Should this adjustable part be small, a pulling will occur on the whole posterior part of the bulb where there is the least resistance. This "optic nerve pulling" hypothesis must also be dismissed on the ground that numerous postmortem examinations have shown that an abnormal shortening of the optic nerve in myopia has not usually been found. Indeed, Stilling found hardly any cases of shortening of the nerve in more than 200 postmortem examinations, and those he found were not in cases of myopia. A constant relationship between the length of the optic nerve and refraction has not been demonstrated.

According to Stilling, a low orbit for this reason predisposes to myopia, because in such a case the tendon of the superior oblique muscle, both in looking down and in reading and writing, can continuously exert pressure on the bulb and thus modify the normal growth of the eyeball. At the same time, according to Stilling, under such conditions, the superior oblique muscle from its posterior bulbar attachment can stretch the optic nerve, and in this manner a myopic conus may be produced. However, the results obtained from later measurements of

the orbital indexes in various refractive conditions contradict these views of Stilling. Myopia was frequently found in a high orbit and hyperopia in a low orbit, and in all these cases the same orbital index was found as in anisometropia, although according to Stilling's theory, a difference should be noted. According to Schmidt, Rimpler and Seggel, the height of the orbit in man should even increase with the enlarging of the eyeball.

Levinsohn, in discussing the cause of myopia, attributed a marked influence to the effect of gravity on the eye during bending of the head. In order to try out his theories, he performed experiments as follows: Apes were held horizontally for many hours daily in specially devised boxes. Food was placed before them and the head was held bent forward to induce convergence, while at the same time the eyes were compelled to look on the floor. Before the experiment, the myopia in one ape was —0 diopter, and in another, —3 diopters; after the experiment, —5 and —13 diopters, respectively. At the same time, with the increase of refraction, ophthalmoscopic changes occurred on the edges of the papilla, which Levinsohn accidentally attributed to these experimental investigations.

These observations of Levinsohn were not confirmed by Behr, who repeated the experiments. Myopia in apes is frequent, but it is most probably a refractive type, which cannot be compared to the progressive axial type in men. Among twenty-five apes, four were myopic—that is, every sixth or seventh ape. An increase in the myopia on account of the artificial hanging of the head was not noted.

Recently von Hasses described the marked crookedness and sinuosity of the optic nerves which occasionally occur in myopic eyes; he said that, on account of the enlarged eyeball, this sinuous part can sometimes be pushed together in a spiral manner. This observation, furthermore, contradicts the Hasner-Weis pulling hypothesis as well as Levinsohn's theory concerning the influence of gravity as a cause of myopia. Vogt stated the belief that the lengthening condition in axial myopia might be attributed to the growth of the retina after birth. He supported his theory on the fixed principle of physiologic growth, which shows that the external and supporting parts and the nourishing tissues adapt themselves in their growth to the organ which they support. The sclera and choroid adapt themselves in their growth to the organ which they support; they adapt themselves to the size of the retina just as the skull adapts itself to the size of the brain. A small retina therefore indicates a short axis (hyperopia); a large retina, a long axis of the eye (myopia).

The character of axial refraction, according to Vogt, indicates the condition of the retinal coverings. On the other hand, Stock and Fleischer said that the thinning and stretching of the sclera at the

posterior pole of the myopic eye cannot be explained according to the hypothesis of Vogt, and that in many cases of the highest degree of myopia, a thinning appearance on the retina may be observed which cannot be explained on the grounds of previous physiologic growth.

I have now mentioned the most important theories which influence the conditions that lead to myopia but have nothing to do with the inherent activity of the eyeball itself.

HYGIENIC CONDITIONS

I will now discuss another important group of theories that associate the existence of myopia with the injurious influences that are apt to occur on account of a continuous, over-strenuous, but in itself normal, activity of the eyes, or such as are due to an increased weakened condition in the function of the intra-ocular muscles. Under modern school conditions, with such strenuous daily intensive work in reading and writing and such an enormous mass of close work for the eyes, one would expect a large number of theories to be proposed regarding the exact cause of myopia.

However, there is constantly before one the fact that only a small proportion of children are myopic, in spite of the fact that the routine study of all school children showed that they averaged the same amount of close study in their daily work. Finally, the close work of children only indicated the direction in which one might seek for results in those who had a tendency toward myopia. There is a wide diversity of opinion among authors concerning the manner and form of the origin of myopia produced by strain and by the abnormal functional condition of the inner eye muscles in the performance of close work.

V. Arlt held the view that close work produces an increase of the intra-ocular pressure in the posterior part of the bulb and also in the vitreous, leading to a thinning of the posterior bulbar wall, with a consequent elongation of the axis of the eye. Under the influence of Cohn and his followers, this belief became dogmatic and for a long time has not been contradicted.

Under normal conditions of close work, one performs practically two kinds of muscle activity: accommodation and convergence. Suppose that an increase of the intra-ocular pressure does follow in close work; the question arises: Does this occur through accommodation or convergence, through the activity of the muscles in the eye or through conditions outside the eye?

Thus arise the hypotheses regarding accommodation and convergence. The hypotheses of accommodation have various interpretations as follows: (1) increase of the intra-ocular pressure through the act of accommodation; (2) pulling on the choroid through the contraction of the ciliary muscle; (3) hyperemia and increased exu-

dation from the blood vessels. All these theories have been abandoned since modern exact investigations have shown their complete instability.

Hess and Heine also observed that the maximal ciliary muscle contraction did not produce an increase in the intra-ocular pressure.

Hensen, Volkers and Hess, by means of fine needles suitably stuck in the eyeball, could observe the moving of these needles when the ciliary muscle contracted. They found that there was a disturbance of the choroid in the anterior part of the bulb, but not in the posterior portion. When the hyperemia was marked owing to the contraction of the ciliary muscle, this disturbance was most noticeable in hyperopes in whom the greatest amount of active accommodation is necessary. The most serious objection to the acceptance of the theory that accommodation favors myopia is the fact that even in cases of myopia of more than 4 diopters, in which accommodation is practically absent, this myopic error frequently increases.

In contradistinction to the accommodative hypothesis, the hypothesis of convergence is supported by numerous well fortified experimental conclusions. It can likewise be proved that contraction of the external muscles under ordinary conditions can produce an increase of the intra-ocular pressure.

For this reason, various effects have been attributed by different investigators to the part played by even a single muscle. Some, especially von Graefe, attribute it to the action of the external and internal recti muscles, while others, as Stilling, make the superior oblique muscle in conjunction with a lowered orbital cavity responsible for the compression in close work.

The increased intra-ocular pressure may be due partly to the working of direct pressure, through the contraction of the external ocular muscles, and partly to indirect pressure, on account of the blocking of the vertebral veins. To understand why the posterior part of the myopic eye is stretched by the working of the muscle pressure on the outside, one must remember that an increased pressure from within can exercise a stretching influence only at places where the equilibrium of pressure is governed by the same or higher pressure on the sclera from without and in the opposite direction. The surface of the sclera which is free from pressure is just that posterior half of the eyeball. According to Halben, to this mechanical principle must be attributed the fact that the eyeball in myopia approaches the oval form and is not enlarged equally in all diameters as it is in hydrophthalmos. A large number of ophthalmologists are of the opinion that the increased intra-ocular pressure arising from a difficult attempt at convergence against an active divergence, in addition to the binocular close work, can unfavorably influence an already existing myopia.

It must, however, be definitely emphasized that the muscular activity coincident with close work is at no time sufficient to produce primarily a myopic condition, as shown by the following three observations: First, every person from his youth must increase his close work, that is, accommodation and convergence; yet few persons become near-sighted. Second, one finds in various countries many workers and whole families of workers with progressive myopia who have learned neither to read nor to write and who during their whole lives have performed scarcely any close work. Third, one frequently sees that myopia is unilateral; that one eye is completely normal and remains so, while the other eye, which is amblyopic and squinting, and never used for close work, becomes increasingly myopic.

One sees, furthermore, that even with the best established theories, the convergence hypothesis, the assistance of an unrecognized factor, all of these cannot be deprived of the support furnished by that mysterious tendency toward myopia.

Therefore, if one finally falls back on heredity it is only a matter of substituting one unknown quantity for another. Certainly heredity plays an important part in myopia. Yet myopia is not inherited as such, but only the tendency to myopia, on the ground that this develops in the course of the person's growth. But so long as one endeavors to find an etiologic prophylaxis and therapy for the myopic problem, one ought not idly or fatuitously take refuge in the idea of heredity, but rather seek for those unknown factors which favor the increase of axial myopia in the growing person.

The most variable factor in human eyes, according to Steiger, is the length of axis. Rightly, however, Siegrist opposed such a view, declaring that one has to consider the myopia as influenced not so much simply by the length of the structure, but rather absolutely by a pathologic thinning process. This is also the starting point for a further increase of the myopic condition.

CONCLUSION

After a review of this critical survey consisting of orderly groups of theories regarding the causes of myopia, one will conclude that none of the opinions mentioned can quite settle the question.

In the last ten years, an enormous amount of statistics have been prepared in reference to the problem of myopia. Neither the unreliable published statistics on refraction, nor the observations relating to heredity, nor the consideration of the various forms of refraction nor even the subject of the changing conditions of the eye has led to an understanding of the real cause of progressive axial myopia.

For so long a time, it has been necessary to grope in the dark and to depend on conjectures that the causes which exactly limit the growth of the eye have not yet been recognized.

An important rôle must be attributed to intra-ocular pressure. During the growth of the eye, it produces a functional strain, considered in the sense of growth mechanism, on the coats of the eyeball and after the cessation of growth, it produces a continuous support which enables the normal position of the inner structures of the eye to be maintained.

Yet, what is known today as final after all these discussions, and which of these theories will remain permanent?

Only by this type of investigation, however, will one be able to recognize the physiologic principle of normal refraction, and can one hope in the future to obtain an insight into the existence of refractive anomalies.

THE FITTING OF ARTIFICIAL EYES

WITH SPECIAL REFERENCE TO GOLD BALL IMPLANTATION *

PIERRE GOUGELMANN

NEW YORK

I believe it is important that the oculist and the manufacturer of artificial eyes should come in closer contact. After all, they are both working toward the same goal, the fitting of the patient with as natural looking prosthesis as is possible. Oculists, in their work, are governed by certain limitations, and I believe that if some of them can be pointed out and explained, a better understanding can be reached.

When a new patient comes to me, my first step is to provide him with a small temporary eye to be worn about two weeks, in order to develop the socket. Long practice has taught me that the best results are obtained by following this method. It is, however, often the cause of great disappointment on the part of the patient, who expects a perfectly fitting eye from the beginning. This is particularly true in the case of foreigners, and I constantly have trouble in convincing them that the final eye will show a marked improvement.

It is estimated by statistics compiled by the government that one of every 300 persons loses an eye. This would mean approximately that 350,000 persons throughout the United States have need for an artificial eye. Formerly, at least 60 per cent wore eyes, the rest had not been educated to their use. Now, whenever an enucleation has been made, the oculist, as soon as the socket is in such a condition as to permit the insertion of an eye, recommends the patient to a specialist in this line. In former years it was customary to consult an optician for a fitting, who, having but a small stock, and that only of shell eyes, would attempt to fit the patient. If he failed to find one that fitted, the edges of the eye were ground on an emory stone to make it conform to the socket. This in itself was a criminal offense, for the patient started with an eye the sharp edges of which so irritated the walls of the socket where the eye rested that in time it caused a severe irritation followed by a contraction of the socket and the development of adhesions.

In 1853, my father, Peter Gougelmann, a pupil of Boesseneau of Paris, who was recognized as the most eminent man in this line, established himself in Van Dam Street, and after encountering innumerable difficulties with a glass that would not crack, manufactured the first eye. This was more than seventy-five years ago, and since then we have handled about 150,000 cases. Some of the most prominent men of the

* Submitted for publication, March 9, 1929.

times are among our patients. A peculiar circumstance in connection with the business is that three patients who have patronized us continually since the year the business was established recently died within a year of one another.

I have personally been connected with this business for almost twenty-five years and must say, from observations made in the course of these years, that vast improvement has been made in the nature of the operations and consequently the improved cosmetic effect of the prosthesis.

Until recent years, the natural stump produced the most satisfactory effect as to both motion and filling up of the socket, though it did not meet with the approval of many of the oculists, the objection being the possibility of sympathetic disease and the possible loss of both eyes. I know of only a few isolated cases in which it was necessary to remove the stump to insure the patient against the possibility of such a dire occurrence.

The gold ball implant, as well as the fat implantation, makes the ideal case, from the standpoint both of filling up the cavity and of the motility of the eye. These two operations give evidence of the greatest advance in enucleations, and stand forth strikingly in an analysis of the progress made in many years. In the majority of such cases the results are all that could be desired. The better the case, however, the more exacting the patient. One would imagine that when a well nigh perfect eye had been obtained, the patient would be happy over the result, but unfortunately this is not true. I have in mind a young woman who was very pretty. I mention this fact merely because it naturally influenced me to do my utmost to obtain the best possible effect. She had a gold implant which gave the appearance of a natural, healthy stump. When she was fitted with a temporary eye, it looked exceedingly well, and when two weeks later the permanent eye was fitted, the whole expression was most natural. Instead of being pleased as I had expected, she objected to a slight difference between the upper lid of the artificial eye as compared to that of the natural eye. Close examination showed that she was entitled to her criticism, but to be able to produce the effect she desired was beyond the power of any mortal.

I have mentioned this case because it is typical of many. The upper lid of the artificial eye often appears to hang over the eye in contrast to the fold of the lid in the natural eye, giving the appearance of a slightly drooping lid. I have repeatedly attempted to overcome this difficulty by adapting a fuller eye, but the fulness thus produced is unnatural and far less pleasing than the original condition. Whether this condition is due to a slight paralysis of the muscle, I do not know. If it is possible to overcome this condition, it would be a welcome relief to such oversensitive patients.

Another difficulty experienced with gold ball implants is that occasionally the ball has a tendency to shift to the inner or outer canthus. Under such circumstances the prosthesis has to be made correspondingly smaller and shallower at that particular point. The fulness of the socket at that point is such that when the patient rotates the stump, it appears to lift the eye instead of assuming the easy natural motion of a normal socket.

I might also add that in some gold ball implants too large a ball is used. This, however, seldom, if ever, occurs in New York, but is fairly often encountered in various other cities. I am obliged to adapt a shell eye in such cases, and even then it often gives the patient the appearance of having an exophthalmic goiter. I find that a small ball invariably produces the best results.

In a number of cases, the gold ball has sloughed out because the tissue was not healthy or strong enough to retain it. However, as one would naturally infer, with the ball removed there would be a severe recession of the socket and a proportionate amount of motion lost. This is not the case; the general effects as to appearance have not been lost, and the movement is in no way impaired.

Less trouble is experienced with the fat implant, though of course, the number of such cases is considerably fewer. There is a certain amount of shrinkage or absorbtion, but it is not sufficient to change materially the usual excellent effect obtained in such cases. I have among my patients some of the first who have undergone this operation, and I can state unhesitatingly that in no instance has there been any apparent change in the appearance due to shrinkage. I have had four cases in which the fat developed after a few years to such an extent that operations to remove a portion of the stump became necessary so that an eye could be inserted.

Another great source of trouble to me is the case, and it is a frequent one, in which the operation has necessitated the removal of so much of the fat or tissue that a considerable depression is left above the upper lid. The socket is usually large, and would suggest the possibility of inserting a good sized prosthesis with normally good results. I find, however, that in most cases the lids are so short that to fit a large eye produces only an unsightly stare and still fails in its object. Neither will a flat eye with a flange nor an eye blown at this particular point remedy the difficulty. They only tend to raise the upper lid, exposing the sclera above the iris, which is a most objectionable feature. I have made many experiments along these lines, and find that there is no remedy. The cosmetic effect is materially improved by the adaption of a smaller eye, though usually much to the chagrin of the patient, and I might add often to that of the oculist.

During the past week I have had two cases in which in place of a gold ball, a calcified bone ball was used. I understand that, owing to the innumerable indentations on its surface, it offers a better chance for the tissues to adhere, thus reducing the possibility of its losing its position. I am endeavoring to obtain some of this calcified bone and shall be pleased to furnish it to oculists who wish to experiment with this form of implant.

Since the inception of the reform eye no marked progress has been made in artificial eyes. This type of eye, however, has been a great boon to the patients, as it did away with the shell which, as the edges were sharp, caused unlimited suffering. Other advantages are that not as large a prosthesis is required and that increased motility is given because of the thick edges of the reform.

In regard to the dilating pupil, I find, after thorough investigation, that it has not as yet reached such a state of perfection as to warrant its adoption. Experiments will continue to be made along these lines, however, and when its merit is proved so that it can be applied to practical advantage, I shall be in a position to introduce it.

TWO UNUSUAL EXPERIENCES WITH STREPTOCOCCUS HEMOLYTICUS *

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PHILADELPHIA

The cases reported in this paper were connected by but one thing, the causative organisms; other than this, they have nothing in common.

CASE 1.—Dr. A. J. B., while entering his home on the evening of Dec. 21, 1926, felt some hot cigaret ashes strike his left eye. While he was treating a patient the following morning, the latter sneezed in his face. By noon the eye was congested and watery, with some slight swelling of the bulbar conjunctiva. He was advised to use neosilvol, boric and zinc sulphate and ice compresses. The eye grew worse, the conjunctiva being very edematous, with only a thin watery secretion and no corneal involvement until the night of December 26, when an attempt to dislodge some secretion resulted in wiping off at least one third of the corneal epithelium. Fortunately, this loss was promptly replaced without infection of the cornea.

Dr. Warren Davis was asked to examine the nasal condition, as the swelling had involved the left nostril, and Dr. Stone made roentgenograms of the teeth and antrum.

Dr. Bucher took cultures from the conjunctiva and from the blood. The former showed *Streptococcus hemolyticus* in pure culture; the latter did not produce any growth.

The patient was seen by Dr. Zentmayer and Dr. Heed in consultation, and the latter suggested the use of foreign protein, which, however, was not used as conditions began to improve, the most efficient remedy seeming to be the ice compresses.

The eye was troublesome until January 17, at which time it seemed normal and remained so for a week, when there was a lighting up of the condition. This attack was slight and lasted about five days.

The most noticeable features of the attack were the great swelling of the conjunctiva, the cornea seeming to be at the bottom of a crater 5 or 6 mm. in depth, and the entire absence of purulent secretion, *Streptococcus hemolyticus* being a nonpus-producing organism. The eye recovered completely, and at present there is no trace of the attack.

The second case was more serious and ended in tragedy.

CASE 2.—R. M., aged 60, a trackman of the Pennsylvania Railroad, was admitted to the ophthalmic ward of the Presbyterian Hospital on Dec. 7, 1928, with a history that on the preceding afternoon, while tamping ties, a piece of ballast broke and struck his left eye. The injury did not prevent him from completing his day's work, but the foreman sent him to the medical examiner the next morning, and he was then referred to the hospital.

He was apparently in good condition on admission, except that his temperature was 100 F. The left eye showed a rupture of the cornea, with the lips of the wound in apposition, the iris not prolapsed but the anterior chamber shallow and the lens hazy. The cornea was clear.

* Submitted for publication, Feb. 7, 1929.

The patient was placed in bed, and the usual local remedies were applied. The next day the temperature was normal, but the cornea had become completely hazed. He was advised of the serious condition of the eye and that enucleation might be necessary; he agreed to have this done when a final decision was reached. The general condition remained good and the temperature normal, but the eye did not improve and an x-ray picture showed no intra-ocular foreign body.

On December 13, a week after the accident, it was obvious that the eye was not going to heal satisfactorily, and enucleation was decided on for the following day. The operation was an ordinary event, the patient being in excellent condition and there being little hemorrhage. That night, however, the wound began to bleed, the bandages being tinged with a thin, bloody discharge, and by afternoon the temperature was 102 F. The stump was the site of a white, well organized, tough, fibrous exudate but otherwise looked normal. A culture was made of the exudate; the orbit was cleaned as well as possible and packed with 1:3,000 corrosive mercuric chloride salve, and 5 cc. of boiled milk was injected into the patient's buttock.

The next day, the second after the operation, there was a rise in temperature to 103 F., and the patient was delirious. Meningitis was suspected, but there were no signs definite enough to warrant such a diagnosis, there being no pain on moving the head and no rigidity of the neck. The wound was still bleeding, and the fibrous exudate had increased. An intramuscular injection of 10 cc. of boiled milk was given with no result. The next morning, between 4:10 and 4:25 a. m., the patient died without any noticeable change in his condition.

Fortunately, a postmortem examination was allowed, and Dr. John Eiman found the following conditions: left sphenoiditis from which a pure culture of *Streptococcus hemolyticus* was obtained, left generalized meningitis and phlebitis of the left cavernous sinus. The cultures from the orbit and blood stream also showed *Streptococcus hemolyticus* in pure culture; there was no sign of a fracture of the skull.

Macroscopic examination of the eyeball showed that the anterior segment was the site of a moderate amount of organized exudate involving the cornea, iris, lens and the most anterior portion of the vitreous. The remainder of the vitreous was clear, and the posterior segment of the globe was normal.

It seems positive that the sphenoid was the starting point of the infectious process, but an interesting field for speculation is found when the route from the sphenoid to the calvarium is considered.

Was the cerebral involvement present before the operation, and if so why was there not a rise in temperature? Did the operation open blood channels for the circulatory and cerebral infection; if so, would the final result have been avoided if an evisceration of the globe with packing of the sclera with corrosive mercuric chloride salve had been done instead of the enucleation?

Dr. Eiman believed that the cerebral involvement was present longer than two days and that therefore the operation did not affect the outcome; however, if this is so, it seems an odd coincidence that the general symptoms with a rise in temperature followed so promptly on the track of the operation.

Notes and News

UNIVERSITY NEWS

Dr. Sanford R. Gifford has been appointed professor of ophthalmology at Northwestern University Medical School.

SOCIETY NEWS

North Dakota Academy of Ophthalmology and Oto-Laryngology.—The annual meeting of the North Dakota Academy of Ophthalmology and Oto-Laryngology was held Thursday, June 6, in Fargo, N. D., Dr. A. T. Bailey, Jamestown, N. D., presiding. Dr. Kenneth A. Phelps of Minneapolis presented a paper on "Sinusitis in Children" and Dr. George M. Constans of Bismarck, N. D., addressed the academy on the subject of "Blue Sclerotics and Brittle Bone Syndrome." Both papers were illustrated by slide demonstrations.

Atlanta Academy of Ophthalmology and Oto-Laryngology.—Dr. Harold F. McDuffie has been elected president of the Atlanta Academy of Ophthalmology and Oto-Laryngology for the year.

GENERAL NEWS

Promotion of Dr. Imre.—Joseph Imre, Jr., professor of ophthalmology at the University of Pecs, Hungary, and director of the Government Ophthalmic Hospital in the same city, was recently appointed to the directorship of the Government Ophthalmic Hospital at Budapest, an institution having a bed capacity of 175.

It will be remembered that Professor Imre in 1926 gave a series of lectures and several courses on operative surgery of the eye, including plastics, throughout the United States. He is well known by ophthalmologists in this country, and his many friends are happy to learn of the great honor bestowed on him.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

STRIAE IN THE EYES OF YOUNG INFANTS. K. JAROSCHKA, Monatschr. f. Kinderh. **42**:528 (Feb.) 1929; abstr., J. A. M. A. **92**:1314 (April 13) 1929.

Jaroschka describes a condition which he says has not been reported before. The eyes of young infants often show circular striae running parallel to the limbus corneae, sometimes on the temporal, sometimes on the nasal side, varying in number and clearness, and interrupting the continuity of the sclera and the conjunctiva. These striae are particularly noticeable in the first two weeks of life; they disappear after the third month. They are milky white and about 2 mm. from the corneal border. The first stria is followed by a second and sometimes a third one. Looking sidewise, one may perceive a slight elevation corresponding to the stria. In several cases the author observed that hemorrhages of the conjunctiva, following birth trauma, stopped at those lines. Elschnig considers them to be the beginning of lateral eye muscles which shine through the delicate infantile conjunctiva. At a more advanced age, the conjunctiva loses its transparency and the lines disappear. They were observed in from 70 to 80 per cent of the infants examined.

W. ZENTMAYER.

Physiology

CONTRIBUTION TO THE ANATOMIC AND FUNCTIONAL STUDY OF THE RETINAL CIRCULATION IN THE AGED. R. BIDAULT, Ann. d'ocul. **166**:15, 1929.

In order to measure the retinal arterial pulse and study the details of the fundus, all patients with disturbance of the media were eliminated. Thirty patients were retained for observation. Only eyes with some pathologic condition had been studied before Bailliart started to measure the retinal arterial tension in 1918.

Bardsley differentiates simple hypertension from arteriosclerosis as follows: In the former condition the vessels are uniformly distended with the light streak larger than normal. The arteries depress the veins more or less. Adams distinguishes three types of hypertension as follows: (1) high arterial tension without arterial or venous signs, (2) hypertension with cardiac and renal lesions and (3) chronic nephritis with secondary hypertension. These are all distinguished by the appearance of the vessels, but Bidault doubts the practicality of this classification.

The most constant senile sign observed was the thinness of the arterial column of blood; associated with this was a slight pallor of the disk and a moderate peripapillar choroidal atrophy.

The retinal arterial tension was found to be about one half the humoral arterial tension. Using this as a relative basis in thirty cases, thirteen cases of relative hypertension were discovered, while seven showed hypotension and ten were normal. Of twenty-one patients between 60 and 70 years of age, eight were normal, eleven showed relative hypertension and two relative hypotension; of six patients between 70 and 80 years, two were normal, two hypertensive and two hypotensive, while all of the four patients over 80 years of age presented relative hypotension. The latter is more frequently encountered in senile eyes, especially in persons over 70 years of age, if pathologic conditions are eliminated.

The hypertension of the cerebrospinal fluid causes dilatation of the cerebral vessels, which in turn affects the retinal vessels. Spasm and anatomic alteration of the central artery at its emergence in the cribriform plate also affect the retinal pulse, causing hypertension. The vessel becomes much smaller after it passes the cribriform plate, especially in aged persons. This is also true of the vein, and most lesions, such as those of thrombosis, occur at this point.

Relative retinal arterial hypotension expresses the mode of retinal circulation in aged persons. The dynamometer shows this condition, of which the ophthalmoscope gives only a faint conception.

H. W. SCARLETT.

CENTRAL AND PERIPHERAL VISUAL ACUITY FOR COLORS. A. FAZAKAS, Arch. f. Ophth. **120**:555, 1928.

The author determined the "minimum visible" or the "minimum cognoscible" for colors, using a black metal plate with holes of 0.085 mm. in diameter through which the colors, dissolved in water, were shown to the person examined. Most of the tests were performed outdoors at distances of from 4 to 8 meters. Red, shown through the 2 mm. hole was recognized at from 5 to 8 meters, yellow and blue at 5 meters, and green, shown through the 4 mm. hole, at 5.75 meters. The shape of the hole had no influence on the results. By varying the distances and the diameters of the holes, the visual acuity for colors was found to follow the same formula as that for the "minimum separable." The diameter of the smallest hole which just enabled a normal eye to recognize the color was proportional to the distance between the examined eye and the target. The macula and the peripheral parts of the retina were examined by this method. In every direction from the macula, the visual acuity for colors decreased regularly except in the parts adjoining the fovea and the extreme periphery of the retina. In these two areas the decrease of visual acuity could not be expressed by any simple formula. For all the other parts the relation held that $y = 1 + \frac{x - 10}{8}$ (y equaling the diameter of the smallest perceivable colored area and x, the excentricity of the point of the retina, expressed in degrees).

The author dealt with the question: Why is the visual acuity in the periphery of the retina so much lower than at the macula? He thinks that the lower accuracy of the peripheral parts of a retinal image is the most important factor. He found that correction of the marginal hyperopia of the retina improved the peripheral visual acuity for colors. He objects to the theory of duplicity because the amount by which the number of cones decreases toward the periphery does not correspond with the change of visual acuity. He thinks that better training of certain parts of the retina depending on the use of the eyes in daily life accounts for some of the difference in the visual acuity. The paper contains valuable material for the physiologist and for the clinician.

P. C. KRONFELD.

Refraction and Accommodation

FRAME FITTING BY PHOTOGRAPHY. E. E. MADDOX, Brit. J. Ophth. **13**:60 (Feb.) 1929.

The author has adapted his squint camera of thirty years ago for this purpose. For the fitting of frames and especially of bifocals, the only rational criteria are the points on the two corneas which the visual axes traverse. These can be mapped out by "circumlental photography," that is, by surrounding the lens of the camera with a reflecting or brightly illuminated surface so as to convert the camera into an observer with an ophthalmoscope. A life-size photograph is obtained showing

the corneal reflection as little white disks with a black spot to indicate the visual axis, in the center of each; this black spot corresponds to the lens of the camera in the midst of its white surroundings. A transparent sheet of celluloid marked with millimeter squares and a white line down the center of the patient's nose is placed over the photograph. Then any asymmetry is at once evident, and the required measurements are made. Celluloid templets cut to the shape of the ordinary kinds of reading segments are laid over the photograph so that if a fine pencil is run around their edge their position and size can be considered. The photograph is taken for a reading distance of 14 inches. That being known, it is a simple matter to read from a table what their separation would be in distant vision.

W. ZENTMAYER.

THE MECHANISM OF ACCOMMODATION. D. CATTANEO, Ann. d'ocul. **166**:32 (Jan.) 1929.

In studying the mechanism of accommodation, three cases of coloboma of the iris and two of aniridia were observed with the slit-lamp.

Spontaneous accommodation was produced in three cases by having the patient look along the axis of the microscope at an object 5 meters distant, and then having him look at a point only 5 or 10 cm. distant. In two cases in which vision was greatly reduced by cataract, accommodation was artificially produced by instilling a few drops of physostigmine (eserine) into the eye.

The object of the study was to determine whether there were any changes in the fibers of the zonule and in the lens and whether the ciliary processes moved forward.

In the first case, one of coloboma, the fibers of the zonule could be seen tightly stretched transversely from the lens. When accommodation was exerted, the filaments became relaxed and curved toward the bottom. They also oscillated slightly with a gentle movement of the eyeball. Physostigmine, 1 per cent, was then instilled and relaxation with oscillation of the fibers occurred, just as in the effort of accommodation. Atropine was next instilled; the pupil dilated, and the zonular fibers became tough. The ciliary processes were not observed.

The second case, one of congenital coloboma, was complicated by a cataract. Spontaneous accommodation, therefore, was not possible. When physostigmine was instilled, the same results obtained as in the first case.

The third case, also one of congenital coloboma of the iris, besides presenting a relaxation of the zonular fibers with oscillation, showed a distinct movement of the lens on movement of the eye and also showed the ciliary processes.

The most interesting case, however, was that of bilateral congenital aniridia. Both eyes showed the same conditions, namely, relaxation of the zonular fibers with undulation, diminution of the lens in its transverse diameter, and the forward movement of the ciliary processes.

These phenomena occurred equally well with spontaneous accommodation and after the instillation of physostigmine. The zonular fibers were seen to arise posterior to the ciliary protuberances and from the recesses between the processes, but not from in front of the latter.

H. W. SCARLETT.

Experimental Pathology

CHANGES IN THE COLOR OF THE IRIS AFTER EXPOSURE TO RADIUM RAYS. L. KUMER and L. SALLMANN, Arch. f. Ophth. **121**:238 (Oct.) 1928.

Children who had been treated with radium because of angiomas of the lids, showed a darker color of the iris of the exposed eye without any other changes.

The darker tint seemed to be due to a stronger pigmentation of the superficial layers of the iris. Children with angiomas who had had no treatment with radium did not show this heterochromia. The examination of forty-one children who had received radium treatment showed that the dose of radium necessary to destroy an angioma does not damage the eye in any perceivable way.

P. C. KRONFELD.

THE CHEMISTRY OF THE REGENERATED AQUEOUS. E. TRON, Arch. f. Ophth. **121**:328 (Dec.) 1928.

The author punctured the anterior chamber of the eye of rabbits twice with an interval of one hour between the two punctures. He determined the chloride and the protein content in the first and second aqueous. These experiments were repeated when the eye was under the influence of a subconjunctival injection of solution of pituitary. The changes in the potassium and calcium content of the regenerated fluid were studied in dogs. The shortest interval between the punctures was one hour, so that a new equilibrium between blood and aqueous could be established.

The author's conclusions are: The second aqueous shows a higher concentration of cations (potassium and calcium) and a smaller amount of anions (chloride) than the first aqueous. The more the protein content of the aqueous increases after the puncture the less chloride is found; this relationship was described first by Ascher. The first and the second aqueous can be considered as ultrafiltrates of the blood. The differences in the chemical composition can be explained by an increased permeability of the walls of the capillaries following the puncture of the anterior chamber. This increased permeability allows the passage of protein and the amount of crystalloids which are normally bound by the colloids of the blood in the anterior chamber. The author objects to Baurmann's opinion that the second aqueous is formed as an ultrafiltrate from the venous part of the capillaries.

P. C. KRONFELD.

Lacrimal Apparatus

LESIONS FOLLOWING THE EXTIRPATION OF THE PALPEBRAL TEAR GLAND. PAUL KNAPP, Klin. Monatsbl. f. Augenh. **82**:241 (Feb.) 1929.

In agreement with Avizonis and with C. H. Sattler, who reported lesions of the globe after extirpation of the palpebral tear gland, the author cautions against this operation. He reports two cases.

A woman, aged 46, had the gland removed in December, 1913, after extirpation of the tear sac. Severe conjunctivitis with a tenacious discharge was noticed, and there was an epithelial defect of the cornea, 4 mm. in extent; these symptoms were seen on the day after the uneventful operation. The sensitiveness of the cornea was reduced and iritis set in. This process lasted for about three weeks. The vision remained subnormal, owing to a macula of the cornea. The author had good results in later operations, being careful not to remove all the lobes of the gland after this experience. Similar conditions, however, developed in a second case. The extirpation of the palpebral gland of a woman, aged 47, was followed by continuation of the tearing for two months. Occasional conjunctivitis and slight keratitis were noticed, until in December, 1928, two years later, the secretion became more abundant and the vision began to fail; the conjunctival sac showed normal moisture, but a thick discharge. The center of the cornea was opaque and some filaments were present. The vision was two tenths. The

other eye was normal. The patient complained of rheumatism of the joints. The irritation disappeared in two weeks, the cornea cleared up to some extent, and vision improved to four tenths. Although two years had passed since the operation, the author blamed it for the filiform keratitis because the second eye remained free. Neither of these two patients had trachoma, in which according to Avizonis, extirpation is contraindicated.

This article was prompted by the recent publication of Wiedersheim who, in the author's opinion, was not convinced of the possibility of these lesions.

K. L. STOLL.

EXTIRPATION OF THE TEAR GLAND FOLLOWED BY LESIONS OF THE GLOBE. T. AXENFELD, Klin. Monatsbl. f. Augenh. **82**:243 (Feb.) 1929.

This operation will retain its merits if performed with proper care; dacryocystorhinostomy will not replace it. The articles of Engelking and of Wiedersheim (*Klin Monatsbl. f. Augenh.* **81**:75 and 757, 1928) are based on experiences at Axenfeld's clinic. Giving full credit to Toti's and similar operations, the author quotes the recent article of Larsson (*Acta ophth.* **6**:193, 1928), who obtained forty-seven permanent cures in a consecutive series of fifty-eight cases, and who succeeded in producing healing in three of the remaining eleven cases by later operations. Axenfeld prefers Toti's method to West's. The extirpation of the tear sac is indicated when changes of the canaliculi exist, in unfavorable conditions of the nose, in tuberculosis and lupus, in some cases of atrophy of the sac and in recurrences of dacryocystorhinostomy. It is indicated, furthermore, in ulcus serpens, coupled with purulent dacryocystitis, and when an urgent bulbus operation is contemplated. All of these conditions may require the extirpation of the palpebral gland later.

The publications of Schoeninger, Betsch and others have shown that the lacrimal secretion may be reduced by hormonal dysfunction and followed by filiform keratitis. Knapp's second case seems to belong to this class. It was the hormonal condition due to rheumatism and not the extirpation of the gland that brought on the filiform keratitis. Hormonal decrease of the lacrimal secretion or, on the other hand, hypersecretion caused by irritation of the accessory elements of the conjunctiva in infectious catarrh may have existed prior to the extirpation of the gland. Lesions of the globe following extirpation of the gland may be caused by diminished tear secretion or by the technic of the operation; for instance, exposure of the cornea by stretching the external canthus, by protrusion of the remaining lobes of the gland into the conjunctival sac after the operation or by the action of the cocaine. The author covers the eye with boric ointment. Diminished secretion on a hormonal base may cause obstinate catarrh with thick discharge; this condition, however, is seen so rarely after the extirpation of the gland that the operation is indicated when trachoma is absent and when Schirmer's test indicates the presence of normal moisture. The tear sac and the gland should never be removed at the same time, but the result of the extirpation of the sac should be watched for a sufficiently long period.

K. L. STOLL.

Conjunctiva

VERNAL CATARRH: ITS TREATMENT BY AUTO-HEMOTHERAPY. CASSINATIS, Arch. di ottal. **36**:9 (Jan.) 1929.

The author reports eleven cases in which this treatment was given with the idea of modifying the constitutional diathesis apparently responsible for the condi-

tion. All but two of the patients were children or adolescents. From six to twelve intramuscular injections of from 5 to 8 cc. were given, injections being repeated twice a week. Marked improvement in symptoms was noted after the third or fourth treatment and in most cases no return of the symptoms occurred during the first season, although the palpebral granulations remained. In Alexandria, symptoms of vernal catarrh are complained of the year around.

S. R. GIFFORD.

Trachoma

TREATMENT OF TRACHOMA WITH TRACHOLYSIN. U. DE FEDE, Arch. di ottal. **36**:1 (Jan.) 1929.

This preparation, sponsored by Angelucci, which is given by subconjunctival injection, is a solution of 1 per cent phenol, sodium nucleinate, sodium sulphate, and calcium glycerophosphate, with 2 per cent procaine hydrochloride. Of ten cases of trachoma in various stages, the author reports cures in all after two or three months. He shares Angelucci's conception of trachoma as a chronic lymphadenitis affecting the conjunctiva as part of a general lymphatic hyperplasia.

S. R. GIFFORD.

Cornea and Sclera

THE OPTICAL CORRECTION OF CONICAL CORNEA WITH THE CONTACT GLASS. D. H. O'ROURKE, Am. J. Ophth. **12**:187 (March) 1929.

The author briefly discusses the evolution of the contact glass and describes a device by which the patient can apply such a glass. This consists of a small wash bottle to the outflow neck of which is attached an ordinary hand bulb. The contact glass can be held by means of a piece of glass tubing surmounted by a rubber holder in the botton of which is a small hole. The bottle is almost filled with water. The patient presses the bulb and applies the contact glass to the holder to which the glass adheres when the pressure on the bulb is released. The glass is filled with salt solution and the patient retracts his lids and places his eye directly over the center of the glass. He then allows his retracted lids to slip over the margin of the glass and presses on the bulb thus releasing the glass from its holder. The author describes one patient who uses a contact glass daily, and whose vision is thereby improved to 6/12 and 6/20 in the right and left eyes, respectively.

W. REESE.

Lens

GLASSBLOWERS' CATARACT. ROLLET, Arch. d'opht. **46:5** (Jan.) 1929.

This paper, which is the report of the International Committee on Occupational Diseases, begins with a historical review of the subject. Next, the various steps of manufacture are described. The frequency of such cataract, particularly in the left eye, and its occurrence in this as compared with its occurrence in other trades are reviewed. Statistics indicate that cataract tends to develop at an earlier age in glass workers than in other persons. In the differential diagnosis congenital and senile cataract must be considered. Many theories have been proposed to explain its development, the most recent being that the infra-red rays are responsible. Vogt has described the changes brought about by these rays in his experimental work.

The author feels that this condition will become a historical curiosity as mechanical methods are developed in the glass-making industry.

S. B. MARLOW.

Glaucoma

A PECULIAR CASE OF GLAUCOMA. E. E. HENDERSON and H. H. JAMES, Brit. J. Ophth. **12**:74, 1928.

When first seen, the patient, a man, aged 40, showed marked dilatation of the episcleral veins. The function of the eye was normal, as was the fundus. Tension of the left eye was fuller than in the right. Fifteen years later, the left eye was congested and the tension full. The cup in the papilla was now pathologic. The upper vessels were tortuous and crowded together at the upper margin of the excavation. The field for white was contracted, the blind spot enlarged, and there was a scotoma below fixation. The eye was trephined. Two years later, vision was normal; there was a small oval field remaining. Tension was full, and the dilated vessels were less noticeable.

W. ZENTMAYER.

Retina; Optic Nerve

A CASE OF RETINITIS PUNCTATA ALBESCENS. P. SCOTTI, Ann. di ottal. e clin. ocul. **57**:45 (Jan.) 1929.

The literature is reviewed, and the twenty-eight previously reported cases are abstracted in a table. The author's case was that of a man, aged 21, whose parents were first cousins. No other cases were found in the family. Corrected vision was: right eye 4/10 and left eye, 1/30; a slight dyschromatopsia for red and green was present, and the fields were contracted, especially in reduced light. The fundus was grayish-brown, with shiny white dots scattered over it everywhere, more densely in the periphery. These were refractile, resembling crystals. After four years central vision was the same, but hemeralopia was more disturbing and the fields were somewhat smaller. The white spots were more numerous, reaching to the nerve, but leaving the macular areas free. Patches of pigment could now be seen in the extreme periphery, especially near the vessels. The poor central vision in the left eye was probably due to amblyopia from anisometropia. The choroid showed numerous atrophic areas, with marked sclerosis of its vessels. This, with the loss of field during four years and the appearance of pigmented spots, puts the case in the class of progressive disease as opposed to the stationary type, which Lauber called fundus albipunctatus cum hemeralopia congenita. The relation of the disease to retinitis pigmentosa and congenital hemeralopia is discussed.

S. GIFFORD.

OCULAR HYPERTENSION IN THE DIAGNOSIS OF GLIOMA AND PSEUDOGLIOMA. V. BARLETTA, Ann. di ottal. e clin. ocul. **57**:66 (Jan.) 1929.

A girl, aged 3, showed a yellowish mass behind the lens of one eye, the tension of which was 12. Six months later, the tension had risen to 28, and the diagnosis of glioma was considered certain, but enucleation was refused for another two months while tension was still high. The diagnosis of glioma was confirmed by section.

S. GIFFORD.

Ocular Muscles

A Scotoma Associated with Strabismus. J. N. Evans, Am. J. Ophth. **12**:194 (March) 1929.

The source of material and the technic used are discussed. A Lloyd stereocampimeter is used. Several tables are given and the following summary is made: (1) the demonstration of an absolute scotoma in strabismus, approximately of 1 degree radius; (2) evidence that the scotoma of strabismus is related to the angioscotoma; (3) evidence that the scotoma in strabismus and its ceccocentral connections are not affected by turning the eye strongly inward; (4) evidence that visual acuity approximately 1 degree about the macula is equal to 6/12, whereas the visual acuity of the subjects of this study average 6/22, and (5) evidence that similar "wandering movements" of the normal eye can be demonstrated by the creation of an after-image scotoma. The author includes a critical review of the literature and various theoretical considerations.

W. Reese.

Concomitant Strabismus and Heterophoria. Kenneth R. Smith, Brit. J. Ophth. **12**:581 (Nov.) 1928.

The author suggests the following definition to include both squint and heterophoria: defect of vision in which binocular vision is absent and there is deviation in the direction of the eyes, so that the visual axes are not directed to the same object.

He describes binocular vision and divergent and convergent squint. A line passing from a point midway between the two eyes to the fixed object-point is taken to represent the axis of binocular vision.

The arrest of development of binocular vision in hypermetropic children is the cause of convergent concomitant squint. The simpler term "one-eyed sight" may safely replace the more cumbersome "absence of binocular vision," for diplopia is absent in children's squint. The arrest of development of binocular vision in hypermetropic children is the cause of convergent concomitant squint.

The author is convinced, after experiments on several children with his binoscope (abstract in same issue, p. 590), that while many hypermetropic children make good progress in acquiring binocular vision for ordinary distances, their vision is not sufficiently clear for near objects to bring about binocular vision, and one-eyed sight is used instead. The unused eye becomes less and less sensitive as this is continued, until one-eyed sight is completely established.

In heterophoria the patient retains such binocular vision as he has already acquired when further progress is arrested, whereas the patient with squint loses that in consequence of its arrest.

The binoscope induces binocular vision by a restoration of the sensibility of the unused eye. With this instrument the actual objects are presented in the central part of the field of vision, instead of the fictitious substitutes employed in the stereoscope.

A. Cowan.

Three Cases of Paresis of the Inferior Oblique Muscle. P. A. Jaensch, Arch. f. Ophth. **121**:113 (Oct.) 1928.

Cases with isolated paresis of the inferior oblique muscle are rare. The author describes a case of pseudobulbarparalysis in a woman, aged 26, with bilateral paresis of the inferior oblique muscle, a slight weakness in both levators and a bilateral supranuclear paresis of the seventh nerve. Paresis of the oblique muscles is most likely due to a nuclear lesion. Two other cases were similar in that

apparently slight injuries caused orbital lesions which led to marked defects of motility. These lesions showed first the more or less typical picture of a lesion of one or two oblique muscles. Comparing the results of the double images test in straight position of the head, however, with those obtained by tilting the head toward the left and toward the right shoulder, discrepancies were found which could not be explained by a lesion of one or two muscles. In all of these cases, therefore, the passive motility should be tested too, in order to reveal fixation of the bulb by strands of scar tissue. After cocainization the eyeball is grasped with a fixation forceps and movements of the bulb in every direction are attempted. This method detects even very thin strands of scar tissue which impede the motions of the eyeball. The differential diagnosis between a real paresis and a pseudoparesis due to scar formation is important as the latter offers the possibility of surgical repair if done in an early stage. The author lays stress on the statement that for a correct analysis of a motor defect of the eye careful studies with all our methods are necessary. Measurements of the horizontal and vertical deviation only, as recently recommended by Hess, are insufficient even for practical purposes.

P. C. KRONFELD.

CONJUGATE OCULAR MUSCLE SPASM IN CHRONIC EPIDEMIC ENCEPHALITIS. H. SJÖGREN, Acta ophth. **6**:97, 1928.

Sjögren reviews the references to ocular disturbances accompanying chronic epidemic encephalitis gathered in the literature and the cases which he studied in the Serafimerlazarette Clinic. He notes that paroxysmal tonic attack of conjugate deviation of both eyes upward and outward seems most prevalent. Occasionally the deviation is downward but rarely in other directions. The onset is sudden and involuntary. As a rule, the patient displays some fatigue or exhaustion before the muscular spasm manifests itself. A psychic stimulation may bring on the muscular disturbance. When the eyes are in the abnormal position, they remain fixed for a considerable period and the position cannot ordinarily be altered at will. Frequently, a nystagmus in various directions has been noted. The palpebral fissures are widely separated, and the lids cannot be closed voluntarily. Occasionally, a clonic blepharospasm has been observed. The patient as a rule is conscious of the disturbance which may last from a few minutes to a whole day. The spasm is often painful and uncomfortable. Often the patient presents other parkinsonian symptoms, especially a facial weakness.

Sjögren reviews the various theories proposed by previous writers. He is not in accord with their assumptions, but believes that the process resembles that disturbance in the seventh nerve which was described by Bell in 1811.

A. M. YUDKIN.

Tumors

TUMORS OF THE IRIS. F. TERREIN, Arch. d'opht. **46**:69 (Feb.) 1929.

Sarcoma is the most frequent form of tumor of the uvea. Sarcoma of the iris, however, is relatively rare. Among 250 sarcomas of the uveal tract reported in the literature only 16 were of the iris, or about 1 sarcoma of the iris in 25,000 patients. It is, nevertheless, more common than epithelioma and carcinoma.

The author presents observations on four atypical cases. The first case had all the characteristics of an epithelioma when examined microscopically, but clinically it could only be designated sarcoma. It exemplifies the necessity of histologic study.

The author next describes the three principle types of tumor that occur in the iris, beginning with sarcoma. His second case illustrates a pseudotumor due to an inflammatory process. It disappeared after the administration of mercury.

Epithelial tumors are thought to arise from the posterior surface of the iris in its pigmented epithelial layer. The first case reported differed from this description. The condition in the third case was sarcoma of the ciliary body although its development corresponded to that of an epithelial tumor. Epithelial cysts of the iris add further confusion in the differential diagnosis of these cases. Two points of value are: tremor of the cyst wall on movement of the eye, and transillumination.

The third type of tumor of the iris is the rarest of all, namely, metastatic carcinoma. The author saw a case which occurred in a woman who had been operated on for carcinoma of the breast two years previously. The tumor develops as small, grayish-yellow specks of varying size situated in the deep layers of the iris. When they appear at the angle of the iris, growth will result more rapidly in secondary glaucoma with all its attendant symptoms.

S. B. MARLOW.

ENUCLEATION OF THE GLOBE OR EXENTERATION OF THE ORBIT IN SARCOMA OF THE CHOROID? R. SEEFELDER, Klin. Monatsbl. f. Augenh. **82**:289 (March) 1929.

The author examined the stimulation of Waetzold who, in agreement with Krafft, demanded the exenteration of the orbit immediately after the diagnosis of choroidal sarcoma has been made with apparent certainty. Waetzold arrived at this point of view as a result of his observations in exact microscopic examinations of twenty-seven globes; he found extension of the tumor itself into the blood-vessels and lymph ways in twenty cases, and migration of tumor cells via the lymph channels into and through the sclera in twenty-two.

Prompted by this surprising statement, Seefelder examined a series of thirteen cases of sarcoma of the choroid or of the ciliary body. Serial sections of nine of these cases were carefully examined under the microscope. One small tumor was limited to the choroid, while the sclera was involved in five; the sclera was perforated and a small epibulbar node was found in three. The involvements and perforations of the sclera took place along the vessels in every instance, the former near the equator or within the area of the anterior ciliary vessels and the latter near the posterior pole. None of these thirteen patients is known to have developed metastases eight or nine years after enucleation. All but two are living. One man died two years after the enucleation from alleged disease of the bladder. One of the eyes was obtained two years after death from cerebral hemorrhage. Postmortem examination showed no evidence of metastases of the sarcoma. The contents of the orbit were examined under the microscope in three cases with negative results. The presence of so-called adenoid tissue in the orbit could not be established.

Seefelder disagrees with Waetzold's postulate for theoretical and cosmetic reasons: The exenteration would not diminish the danger of metastases in other parts of the body, the dreaded disfiguration might deter many patients to their own detriment. He reserves the exenteration for those cases in which a recurrence is found in the orbit itself. These recurrences may occur after long periods of time, but they are known to be rare. E. von Hippel contends that the organism will resist isolated cells that might possibly be left after the enucleation. The

author is in the habit of enucleating the globe with the adherent orbital tissue and as long a piece of the optic nerve as may be obtained. The exenteration may follow, with the consent of the patient, whenever a perforation through the sclera is seen macroscopically. In all other cases the exenteration should be resorted to only when suspicion of an involvement of the orbital tissues has been aroused by serial sections of the enucleated globe. Four to six weeks consumed by the preparation of the slides is of no consequence, on account of the slow growth of the sarcomas. Most of the orbital neoplasms, furthermore, show a decided tendency to encapsulate, so that in a number of cases they may be removed with preservation of the globe and even of sight.

K. L. STOLL.

Operations

THE CONJUNCTIVAL BRIDGE IN CATARACT OPERATIONS. C. T. EBER, Am. J. Ophth. **12**:106 (Feb.) 1929.

The author uses a conjunctival bridge measuring from 10 to 12 mm. on completing his section. A subconjunctival injection of procaine hydrochloride and epinephrine hydrochloride near the upper limbus facilitates the cutting of the bridge, augments the anesthesia and helps control the bleeding. A specially designed, toothed forceps is used to depress the sclera, raise the conjunctival bridge and finally grasp the expressed lens.

W. S. REESE.

Therapeutics

TREATMENT IN OCULAR DISEASES BY ULTRAVIOLET RAYS. N. BRAUNSTEIN, Ztschr. f. Augenh. **4**:232 (July) 1928.

Braunstein reports a series of cases of disorders of the iris and cornea and resistant conjunctival disorders which improved under ultraviolet therapy. The cases include ulcus serpens, herpes, parenchymatous keratitis, tuberculous conjunctivitis, corneal opacities and eczematous keratitis. He used the carbon arc lamp with the uviol filter, according to the method of Birch-Hirschfeld.

Treatment was given for from five to six minutes for the iris; from five to ten minutes for the cornea; and twenty-five minutes, with the eyeball protected, in some cases of tuberculosis of the lid. Irradiations were made twice daily, the treatment never lasting more than six weeks. In corneal ulcers 0.5 per cent solution of fluorescein was instilled for sensitization.

Improvement in old corneal opacities, prevention of opacity in interstitial keratitis and relief of photophobia in eczematous keratitis are among the most gratifying results claimed.

S. J. BEACH.

CORRECTION

In the Index to Volume 9 of the Archives of Ophthalmology which appeared in the June issue, the following article was listed:

Smith, J. W.: Case of sympathetic ophthalmia occurring 48 hours after injury, with microscopic sections.

The title should have been:

Case of sympathetic ophthalmia occurring 48 years after injury, with microscopic sections.

Society Transactions

EDITED BY DR. GEORGE S. DERBY

ROYAL SOCIETY OF MEDICINE, OPHTHALMIC SECTION, LONDON

H. DICKINSON, *Reporter*

Feb. 8, 1929

CYRIL WALKER, *President, in the Chair*

ROENTGEN TREATMENT FOR PITUITARY TUMOR. MR. GRIFFITH.

A man, aged 48, in September, 1925, began to notice vague difficulties with reading; this was soon followed by headache, giddiness and staggering gait. By March, 1926, although the vision remained 6/6, a bitemporal central scotoma was discovered. Exploration was advised. Declining this, the patient went to Paris and had a course of twenty-six roentgen treatments. Relief from headache and giddiness began, with improvement in fields. The central defects charted with a red test object, however, remained as large as those previously obtained for white. Mr. Griffith did not wish to be understood to advocate roentgen treatment for all cases of pituitary tumor, but he stated that good results might be obtained sometimes when operation is refused. At the same time, he expressed his belief that fibrosis occurring after irradiation might render a subsequent operation more difficult.

DISCUSSION

MR. DAVENPORT: I know of two cases of pituitary tumor in which the patients were benefited by roentgen treatment.

SPONTANEOUS FILTERING SCAR. MR. MCCALLUM.

A veteran of the South African War, who had never consulted an ophthalmic surgeon, appeared to have a trephine wound. At one time he had done a good deal of boxing, and probably sustained a rupture of the sclerotic membrane at the limbus which produced the condition mentioned.

DISCUSSION

MR. CYRIL WALKER: I recall the case of a man supposed to be a malingerer in whom no history of injury could be gleaned during his life-time. Before death, papilledema appeared. After death the patient was found to have a pen with two and one-half inches of penholder in the left frontal lobe.

TUMOR OF THE IRIS. MR. MCCALLUM.

A boy, aged 8 years, was said to have had a red swollen eye for one week. The vision was less than 6/60, while that of the other eye was normal. The affected eye showed keratitis punctata, with nodular swellings of the iris, and a white fundus reflex at one spot, suggesting the possibility of tuberculosis, glioma or, perhaps, lymphosarcoma.

DISCUSSION

MR. CYRIL WALKER: I recall a similar case in which a microscopic examination demonstrated a sarcoma.

COMPLETE HYALOID ARTERY. MR. WITTINGTON.

In a boy, aged 11 years, with 6/24 vision with a plus 6 diopters lens, the slit-lamp showed a complete vessel with all its branches, and the hyaloid sheath fading off into the vitreous.

DISCUSSION

MISS IDA MANN: A partially persistent hyaloid is common, but I have never seen such an excellent example of arrested development as this. It represents the development at the sixth month.

AFTER-RESULTS OF IRIDOCYCLITIS. MR. CUNNINGHAM.

Ultraviolet rays were administered more than three years before presentation, to a patient with iridocyclitis. For over two years the eyes have been quiet, except for attacks of bullous keratitis. Mr. Cunningham thought that liquid petrolatum drops helped to prevent recurrence.

HEMANGIOMA OF THE CEREBRAL MENINGES. MR. R. FOSTER MOORE.

A boy, aged 12, was seen for defective vision in the left eye. In 1925, his visual acuity with a small hypermetropic and astigmatic correction was 6/9 in the right, and 6/12 in the left eye. The left eye had become worse during the year before presentation. The patient's father was said to have become blind from locomotor ataxia.

Examination showed a nevus of the left half of the face involving the eyelids. With correction, the visual acuity of the right eye was 6/9, and of the left 6/6. The left pupil reacted poorly to light. There was a small coloboma of the left optic disk and a slight congenital dislocation of each lens. The visual fields showed an incomplete right homonymous hemianopsia.

In the absence of any demonstrable cerebral tumor or abscess, Mr. Moore, on account of the nevus of the face, considered the possibility of intracranial nevus, and suggested roentgenograms of the skull. Roentgenograms gave striking evidence of a new growth of large blood vessels, the walls of which appeared to be calcified and greatly thickened.

DISCUSSION

DR. PARKES WEBER: In a similar case, a girl had a blind buphthalmic eye. A photograph was shown that pictured the extent of the cutaneous hemiangioma of the face. The patient had congenital spastic hemiplegia of the face and sexual infantilism. X-rays of the skull revealed nothing abnormal. In eight cases of the kind in which the results were published, there was unilateral buphthalmos on the side of the nevus.

MR. LESLIE PATON: Mr. Williamson-Noble, Dr. Greenlees and I are investigating a case of Lindau's disease (angiomatosis of eye and cerebellum). In another case, a girl had acute glaucoma and hemorrhage so extensive that the eye had to be removed. On account of definite intracranial symptoms she was operated on for cerebral tumor. Unfortunately, the approach was made supratentorially, whereas the tumor in this case was subtentorial, as it almost always is. A subtentorial exploration is now being considered.

REPORT ON GLIOMA RETINAE. MR. R. FOSTER MOORE and MR. SCOTT.

Two infants had bilateral glioma of the retinas. In each patient, examination showed a small growth in each retina. In cases of this kind both eyes should not be removed until a thorough examination has been made with the patient under a general anesthetic. If the parents withhold their consent to remove the eyes, radium should be tried.

IRIDODIALYSIS OF THE PIGMENT LAYER OF THE IRIS. MR. BASIL GRAVE.

For several years, evidence was collected tending to show that detachment of the posterior pigment layer of the iris from the anterior layer, by injury or by pathologic changes, was by no means uncommon. The tendency to the reopening of this embryonic potential space is thought to be even greater than the analogous occurrence farther back in the eye, namely, detachment of the neural retina from the retinal pigment epithelium.

By means of transscleral illumination, a form of effectual and intense retro-illumination, it may be shown that the translucent stroma of the iris obstructs the passage of light but little, and negligibly so in comparison with the posterior pigment layer of the iris.

The anterior layer of pigment (the dilator muscle) is considered to be intimately and inseparably attached to the mesodermal stroma, but the thick posterior pigment layer is a structural entity. The latter is ductile to a certain degree but inelastic. It will stretch to a certain limit but will not return of its own accord to its initial form after it has been subjected to expansion or contraction. It returns to its initial form only by virtue of its attachment to the muscle-containing tissue.

Transscleral illumination used in a routine manner in all classes of cases for several years has revealed a definite condition resulting from concussion; namely, a separation of the posterior layer of pigment from the anterior layer of pigment, a condition which is clinically detectable by no other means. In medicolegal cases, when the question of injury is in dispute, the presence of such a condition may be of value. There are certain conditions that simulate the traumatic separation, but they are readily distinguishable after a little experience.

It would be easy to coin a term for this condition, such as "melanodialysis," or "epidialysis" from the fact that the tissue involved is derived from neural epiblast. "Mesodialysis" thus would indicate a separation of mesodermal stroma from the anterior pigment layer or the dilator muscle, a condition which the observer has never encountered.

He obtained the evidences of this condition mainly through access to cases at Moorfields between 1919 and 1923, and since then in Pennsylvania and New York hospitals and, to some extent, in private practice.

MR. H. DICKINSON, *Reporter*

Clinical Meeting, March 8, 1929

MR. CYRIL WALKER, *President, in the Chair*

CHOLESTERIN CRYSTALS IN THE ANTERIOR CHAMBER. MR. P. G. DOYNE for MR. CARDELL.

The case was first seen in 1923. There was a history of the lodgment of a foreign body. The x-rays disclosed it, but the magnet was ineffectual to remove it. The case was only seen comparatively recently, and the eye had become painful.

MELANOSIS OF THE EYEBALL. MR. J. F. CUNNINGHAM.

The man did not obey the advice given eighteen months before to enter the hospital. The general opinion of members was that the eye must be removed. It was intended to remove the fleshy mass first, and have it examined.

DISCUSSION

SIR WILLIAM LISTER: I had a somewhat similar case in which the condition spread into the substance of the cornea; finally the eye had to be removed. Have any of the members seen such cases go on to sarcoma? The eye nearly always has been removed before the sarcoma occurs.

MR. P. G. DOYNE: I saw a case which began in 1918, and in which I think radium was used originally. A small fleshy lump had been excised, and the patient was sent to the Radium Institute in 1923. In 1928, she entered the hospital on account of suddenly failing sight; the eye had to be removed. In this case there had been a long latent period, followed by a poor course.

MR. PICKARD: The condition might be attacked with diathermy. This might be safer than a cutting operation, and would be less likely to be followed by recurrence.

MR. J. H. FISHER: The same considerations apply to pigmented moles elsewhere in the body. Mr. Shattock thought that no man should allow a pigmented mole to remain in his body after his fortieth year. It would be unwise not to have a pigmented mole on the eyeball removed.

MR. CYRIL WALKER: I had a similar case, in which a nodule on the lid was obviously increasing. The removed portion was definitely sarcomatous. At the meeting at which it was shown, Colonel Lister felt sure that it would become malignant. I removed all the pigmented area, including, of course, the eyeball, conjunctiva and lid. During the year since the operation, there has been no recurrence.

MELANOMA OF THE CHOROID. MR. FRANK JULER.

The condition was accidentally discovered during examination of the fundus when the patient came for glasses. He had not yet been examined for scotoma.

DISCUSSION

MR. REA: I had a patient with a large patch on the temporal side of the retina with eleven satellites around it. There was no diminution in the field of vision. The condition remained stationary for four years.

RODENT ULCER OF THE LID. MR. FRANK JULER.

A swelling of the upper lid was present in a patient for twenty-one months, but there had been an increase in the last six weeks. There was ample confirmation of the nature of the case at the meeting. The question raised was whether excision should be done, or radium or another agent applied. Radium seemed preferable as the resulting deformity would be less than after excision.

DISCUSSION

MR. O. G. MORGAN: In one case of the same kind, cure by radium took a long time. If a rodent ulcer is free from periosteum or mucous membrane and can be removed, it is much better to do this immediately.

MR. E. R. CHAMBERS: I saw a case of this nature in which the condition healed completely under treatment with radium four months ago; so far, there has been no evidence of recurrence.

PERFORATING WOUND OF THE EYEBALL. MR. HUMPHRY NEAME.

There was a small prolapse of the iris. The piece of wood that caused the injury contained a nail projecting for three-fourths of an inch (19 mm.); the man did not know whether the point of the nail hit the eye, but this seemed likely. Would it be safer to leave the condition alone or to try to free the prolapsed iris? In the latter event there would be a risk of pulling the ciliary body into the wound.

DISCUSSION

MR. FRANK JULER: I should dissect down the conjunctiva, turning it down into a flap, and get hold of the projecting tissue of the iris.

MR. B. CRIDLAND: I have seen a number of cases of this sort. Usually I snip off the prominent tissue and cover it with conjunctiva.

MR. FISHER: I use the galvanocautery to burn the pigmented tissue away, and then cover the area with a flap of conjunctiva.

SIR WILLIAM LISTER: Much depends on the stage at which one has the chance of operating; if it is within a fortnight after the injury, there is a good possibility of freeing the iris by a simple operation.

OPTIC ATROPHY AFTER ARTERIOSCLEROSIS, WITH PAPILLEDEMA. MR. HUMPHRY NEAME.

The swelling was 4 diopters in each eye. There were abundant retinal hemorrhages, venous engorgement and a marked arteriosclerosis in the retina. The general blood pressure was high. There was only a slight defect in renal function. The Wassermann reaction was negative. The patient's age, 35, was unusually young for the degree of arteriosclerosis present. At the time of presentation marked improvement was noted. Formerly the man had had only perception of shadows in each eye; vision had improved to 6/18; there was no improvement in the right eye.

PIGMENTARY DEGENERATION OF THE RETINA. MR. E. WOLFF.

A woman, aged 57, came to the hospital complaining of near vision; for ten years she had had difficulty in seeing at night. The periphery of the fundus was like that in ordinary retinitis pigmentosa. Vision had diminished to 6/9. The whole lower part of both fundi was speckled with cholesterin crystals. Though the Wassermann reaction was negative, the family history suggested that the condition was syphilitic.

DISCUSSION

MR. CYRIL WALKER: This condition seems to be secondary to definite choroiditis.

CONGENITAL DISLOCATION UPWARD OF BOTH LENSES. MR. E. WOLFF.

A number of relatives of the patient had defective vision, but they had not been examined. The slit-lamp showed the fibers of the suspensory ligament to the lens.

DISCUSSION

MR. REA: Both lenses were dislocated in a woman and in her daughter. The mother was operated on, but as a result it was decided not to operate on the daughter.

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Feb. 21, 1929

WILLIAM ZENTMAYER, M.D., *Acting Chairman*

PULSATING EXOPHTHALMUS. DR. GEORGE SCHWARTZKOPF (by invitation).

A woman, aged 55, was presented, with pulsating exophthalmus of the left eye due to traumatic aneurysm in the cavernous sinus. The patient had been under observation for almost two years. Surgical intervention had been impossible because of the bad general condition of the patient. The exophthalmus appeared four weeks after a severe automobile injury, with fracture of the upper jaw, extending to the vault of the hard palate. The treatment was symptomatic, and the digital compression, which was tried for three weeks, was not well tolerated. Nevertheless, the condition improved amazingly, temporary high tension of the left eye having to be relieved once by a cyclodialysis, as miotics did not relieve the pressure. In the first year after the accident, the exophthalmus, with its typical symptoms of bruit, tortuous conjunctival and retinal veins, thin arteries and retinal hemorrhages, varied, as did the subjective feeling. Diplopia with esophoria existed for about one month, but vanished spontaneously without recurrence.

At the time of presentation, the patient was feeling well, did all the housework and had no complaints, except that colds seemed to cause a slight increase of congestion in both eyes, which were about equally prominent. Pulsation and bruit were distinct, the latter being observed by the patient only if her attention was called to it.

BILATERAL TUBERCULOUS CHOROIDITIS. DR. ABNER R. RENNINGER (by invitation).

The case of a girl, aged 10 years, with a history of rapid failure of vision in the right eye was presented. She was first seen on Jan. 14, 1929, at which time the vision was reduced to 3/200. The ophthalmoscope revealed a crescent-shaped, grayish-white, elevated area to the temporal side of the disk. In a few days, there were general choroidal edema, dustlike opacities in the vitreous and deposits on the posterior cornea. Nineteen days later, the left eye (which had been normal to that time) became involved in an identical way. The vision, however, did not fall below 20/70.

A complete medical examination was made, and the only positive observations were the reaction to tuberculin and the presence of a calcification in the left side of the chest. Treatment consisted of biweekly injections of tuberculin, mercurial unctions and increasing doses of potassium iodide.

At the time of presentation, the choroidal edema had entirely disappeared from both eyegrounds. There remained, however, several oval, white patches

in each eye, which were located near the margins of large retinal vessels. The vision in the right eye had not improved. In the left, it had been restored to 20/40 plus.

DISCUSSION

DR. EDWARD A. SHUMWAY: I saw the patient in consultation with Dr. Renninger, made a diagnosis of acute plastic choroiditis juxta papillaries in the right eye, and advised sending her to the hospital for examination. The left eye subsequently became involved, and the process rapidly advanced in both eyes. Recently, the appearance of scattered yellowish-white areas gleaming through the retinal edema has made the diagnosis of a tuberculous choroiditis practically certain, especially as all other laboratory examinations have proved negative, with the exception of the tuberculin skin test, which is strongly positive. There are two types of tuberculosis of the choroid, the miliary type, associated with acute miliary tuberculosis in its late stages, and the conglomerate type, with the formation of a large tumor mass, which shows the well known characteristics of tubercle elsewhere — giant cells, with central caseation and surrounding epithelioid and round cells. Occasionally, the tubercle bacilli can be demonstrated. With the projection lantern, a number of microscopic slides illustrate the condition both in the choroid and in the iris.

SCHILDER'S DISEASE. DR. FREDERIC H. LEAVITT.

During the past few years, a disease process involving the subcortical tissues of the brain, occurring principally in young children and characterized by blindness, has been described in the literature. In his original monograph in 1912, Paul Schilder of Leipzig defined the condition in the following way: "A diffuse disease of the white matter of the hemispheres occurring in childhood, which, because of the characteristic macroscopic and microscopic findings, may be regarded as a disease entity." Because of his thorough description of the condition, it has been given the name "Schilder's disease." Several writers before and since the publication of his article have described conditions occurring in children which are similar in the clinical picture and in the pathologic observations. In 1867, Virchow first described this syndrome under the caption "congenital interstitial encephalitis," and as late as December, 1928, Globus and Strauss took exception to the term "Schilder's disease" and advocated the use of the appellation "degenerative subcortical encephalopathy."

The disease is fatal, and there is only a slight tendency for remission. The majority of cases are rather abrupt in onset and run a rather rapidly progressive course. Blindness, with or without atrophy, varying degrees of coma, increasing generalized spasticity with opisthotonos and decerebrate rigidity and myoclonic convulsive attacks make up the clinical picture.

Pathologic examination of the brains of patients dying with this condition reveals a decided hardness of the entire brain with a general shrinking in toto. Microscopic examination reveals a practically normal cortex with an intense degree of degeneration of the white fiber tracts characterized by destruction of the myelin sheaths and axis cylinders and an overgrowth of neuroglia tissue. This destructive process frequently begins in the occipital lobes, accounting for the appearance of blindness in the early stage of the disease process with no demonstrable changes in the eyegrounds. Occasionally, optic atrophy occurs, secondary to the destruction of the visual centers.

The case presented was that of a mulatto boy, aged 4 years, who gave a history of gastro-intestinal upset followed by two weeks of apparent recovery, and then a rather rapidly developing syndrome characterized by a disturbance of gait (cerebellar ataxia), increasing coma, myoclonic rhythmic convulsive seizures, increasing blindness with negative eyegrounds, dysphagia, decerebrate rigidity with opisthotonos and normal temperature, symptoms of the spinal fluid, electric reactions and a characteristic blood picture. This patient was living at the Children's Hospital in Philadelphia and because of the resemblance of the condition to acute multiple sclerosis, he had been treated by intravenous injections of "germanine" every four days. The only improvement noted from this therapy had been the disappearance of the myoclonic convulsive attacks, the other characteristics of the clinical picture remaining as before.

DISCUSSION

DR. E. A. SHUMWAY: I examined the patient at the Children's Hospital a number of times, and, when the diagnosis was made, urged Dr. Leavitt to present the case before the section, as one with which the ophthalmologists should be familiar. During the period that the child showed spasms of the face, the eyes also presented clonic movements, and at one time there was a definite conjugate deviation to the left. Because of the mental torpor, functional tests for vision were not possible, but the attending nurses reported a gradual failure of vision, noted in bringing food cups to him, and at present the child seems practically blind. At no time have there been any lesions of the fundus. I have also seen a second case of Dr. Leavitt, and the optic nerves in this patient showed atrophy. I desire to thank Dr. Leavitt for his presentation of this comparatively new syndrome, about which a number of papers have appeared in the recent neurologic literature.

DR. YASKIN: Schilder's disease resembles multiple sclerosis not only pathologically by the exclusive involvement of the white matter but also from an ophthalmologic standpoint. In both diseases the physician does not see and the patient does not see, that is, the ophthalmologic examination reveals no cause for the blindness in the former, and the common occurrence of retrobulbar neuritis in multiple sclerosis has the same clinical manifestations. Another interesting point about Schilder's disease is that it sometimes occurs rather suddenly, resembling apoplectiform attacks, and again may, in one of its forms, resemble a tumor of the brain, so that useless operations are known to have been performed because of the failure to recognize this condition.

SPONTANEOUS NYSTAGMUS. DR. JOSEPH C. YASKIN (by invitation).

For clinical purposes, spontaneous nystagmus is divisible into labyrinthine, neurologic and ocular types, based on an etiologic relationship to anatomico-physiologic changes respectively in the labyrinth and its vestibular projection, in the posterior longitudinal bundle and allied central structures and in the optical fixation. A simple and rapid method for determining the type of spontaneous nystagmus, as suggested in the presentation, consists in observing the type, direction, degree, frequency, amplitude, association and permanency of the nystagmus movements. These observations render it possible to determine the origin of the nystagmus in a few moments. The high frequency of ocular nystagmus is stressed, especially because it is the most benign type of nystagmus. The nature of diplopia, occurring with nystagmus, independent of any paresis of an extra-ocular muscle is discussed. The conclusion is that under these conditions the diplopia is due to a rather serious involvement of the central nervous system.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

THOMAS H. JOHNSON, M.D., *Secretary*

Regular Meeting, March 18, 1929

BERNARD SAMUELS, M.D., *Chairman*

A WORKING MODEL OF EYE MUSCLES FOR TEACHING PURPOSES. DR. WENDELL L. HUGHES.

The model I have developed incorporates many of the features of an ideal model with some new ones I have not seen in any other model, this being justification for its presentation.

It consists of a plaster of paris model of the lower half of the bony orbits with two wooden balls excavated posteriorly, where each one is suspended by a small ball and socket joint so it may be rotated in various directions. The muscles are represented (as shown in the illustrations) by cords, in the course of which are placed springs to represent the tonicity and elasticity of the human ocular muscles. These are placed in the normal anatomic relationship to the bony walls and optic foramen. Instead of having these cords end at the optic foramen I have continued them through this aperture so that they may be activated by pulling the strings entirely from behind, in this way representing the result of stimulation of an individual muscle or various combinations of associated muscles.

The cords representing each pair of associated muscles come together posteriorly so they may be easily grasped at once. The left lateral rectus and the medial rectus of the right side are so arranged that they may be fastened posteriorly by a small hook and eye arrangement in a taut position carrying each eyeball to the left. With the eyes in this position, the elevators having their field of action in this direction may be readily demonstrated by pulling on the cords controlling the associated left superior rectus and the right inferior oblique muscles. Similarly, with the eyes still held to the left, the depressors having their field of greatest action to the left may be shown by activating simultaneously the left inferior rectus and right superior oblique muscles taking the eyes down in the left field.

The same relative predominantly acting muscles in the right field may be shown by fastening the right lateral rectus and left medial rectus muscles taut and activating the elevators (*R.S.R.* and *L.I.O.*) and depressors (*R.I.R.* and *L.S.O.*) taking the eyes up and down, respectively, in the right field.

The action of each individual muscle is easily shown by pulling on a single cord controlling the corresponding muscle. Primary and secondary actions are equally well shown, e. g., the torsion effect around the horizontal axis of the individual superior and inferior recti and obliques, the abducting effect of the combined action of the superior and inferior oblique and the adducting effect of the combined superior and inferior recti muscles of each eye.

Paralyses of individual muscles are represented by simply detaching the muscle represented as paralyzed, the tension of the springs in the remaining cords carrying the schematic eyes away from the field of action of the paralyzed muscles, the limitation of motility and deviation of the optic axes being well shown.

Spasms may be shown by pulling more on the cord controlling the muscle being represented as spastic than on the associated muscle.

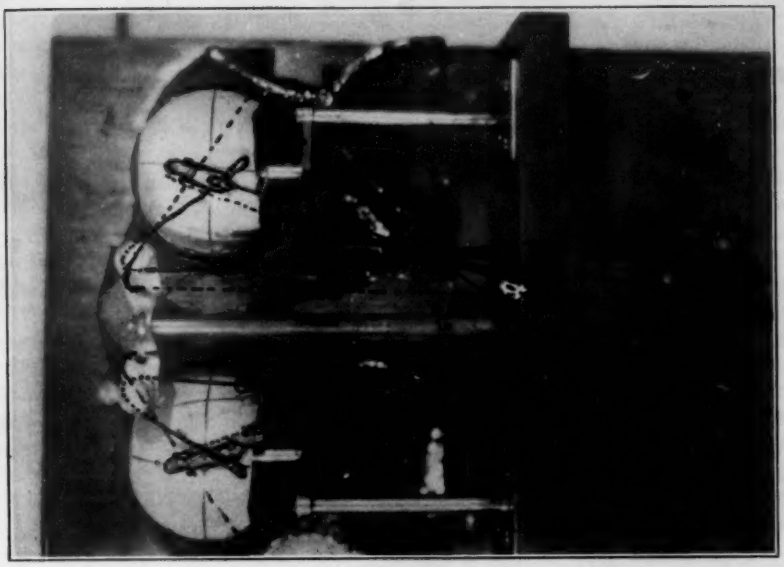

Fig. 1.—The model, showing the relative direction of the muscles and mechanical arrangement.

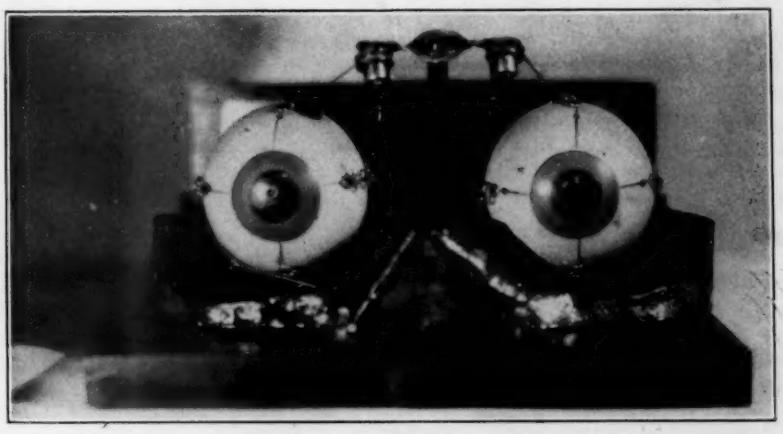

Fig. 2.—Front view showing the plaster of paris model of the lower half ot the bony orbit.

The operations that are performed on the ocular muscles are demonstrable: (*a*) recession or tenotomy by removing the muscle from its original insertion, and reattaching it to the more posterior attachment provided; (*b*) advancement by bringing the muscle forward and reattaching it by its more posterior loop situated back in the muscle and leaving the end of the muscle in situ, it being near the limbus where it would be sewn in the operative procedure; (*c*) resection by a similar procedure (*b*) except that the end which would ordinarily extend forward to near the limbus is doubled back representing its removal; (*d*) tucking by bringing the more posterior loop forward to attach it to the same place as the loop at the end of the muscle, thus producing the effect of a tucking operation.

The use of this model with moving picture demonstration as well as actual movement of the schematic eyes has greatly simplified the usual difficulty in teaching the muscle anatomy, primary and secondary actions, physiologic fields of action, associated movements and the mechanics of the operative procedures that are performed.

The model can be made to any scale, this one being 2.5 times the anatomic measurements in all respect with the exception of the intercentral distance. This was reduced by lessening the relative amount of space occupied by the nasal structures to make the model more compact.

The box in which the model is carried is designed to carry a set of prisms, the lower half of a skull, two books and various small instruments and cards used in teaching.

DISCUSSION

DR. JAMES W. SMITH: I believe that Dr. Hughes' model could be further simplified for teaching purposes if the attachments of the eye muscles were indicated by letters or abbreviations, for example, *Int. R.* for internal rectus, *Sup. O.*, superior oblique, etc. Students have particular difficulty in understanding the origin, insertion and action of the oblique muscles.

SOME PRACTICAL POINTS IN THE ADMINISTRATION OF TUBERCULIN. DR. ELSE A. BARTHEL.

Of three solutions that I use, I feel that I get my best results from a fresh dilution of old tuberculin in saline. Each cubic centimeter of tuberculin contains 1 Gm. of the soluble toxin. The dilutions are made 0.1 cc. of old tuberculin to 0.9 cc. of saline directly into a 1 cc. tuberculin syringe. Rotated from five to six times to get a uniform distribution, 0.9 cc. is then discarded and the syringe is again filled with saline, and so on until one gets a 1:1,000 dilution for skin tests, and a 1:100,000 for therapy purposes. The board of health makes up the old tuberculin that I use and also a combination for the skin test similar to the Schick test. The tuberculin is 1:100 dilution and a bottle of saline. The solutions are put together exactly as for a Schick test, and 0.1 cc. is used intradermally and then read in forty-eight hours.

A positive reaction to the test shows a red papule about 2 cc. in size, or it may be larger. The lesion may be infiltrated, and the skin may go on to vesiculation. The temperature is taken every four hours, and the patient is asked to report nausea and vomiting or general indisposition. A slight congestion about the lesion means a positive focal reaction. The site of injection is looked at again in four or five days.

A positive reaction to the skin test often causes an improvement in the clinical condition.

My cases at this time are largely dermatologic, and at times I get a rather tremendous reaction locally without much general disturbance and a good focal

response. Dr. Krumwiede thinks that this is due to the low skin resistance of the patients and that there would be no such reaction in patients with eye conditions. Furthermore, he does not believe that the focal reaction would be too marked.

A von Pirquet test is less sensitive and may give a negative reaction.

I never start treatment until all reaction from the skin test has disappeared. Then if the response to the skin test has been marked, the first dose is 0.05 cc. of no. 6 dilution, otherwise 0.1 cc. of no. 6 dilution. The injection is given subcutaneously over the deltoid. The legs are unsatisfactory as the site of injection, as the reactions are much more intense, resulting in discomfort and a delayed increase of dosage. If there is no reaction, I give, in a week, a second dose of 0.2 cc. and keep on increasing the amount by 0.1 cc. at weekly intervals. I increase the dose up to 0.9 cc. of no. 6 dilution, then the next dose is 0.1 cc. of no. 5 dilution. That is then increased to 0.9 cc. and the next dose is 0.1 cc. of no. 4 dilution, and so on to no. 3. I never give more than 0.4 cc. of no. 3 dilution. If the patient says that there was a red spot at the point of injection for a day or two but presents a normal arm a week later, the same dose is repeated. But should there remain a nodule in the subcutaneous tissue, 0.1 cc. less than the previous dose is given. Should the skin show any involvement, the dose is omitted that week. If a dose were given under these circumstances, the activity in the older site of injection increases, and it is difficult to say how far it will go. The limit of the reaction is often not reached for weeks, and it may go on to ulceration.

The patients are always sent away with the instructions that if the arm should feel sore, a large cold compress is to be applied.

I prefer not to produce a reaction. The most marked results, clinically, seem to be obtained with the earlier doses, and patients certainly object to arms filled with little inflammatory nodules or to painful arms especially if the treatment has to run over months, as it often does.

DISCUSSION

Dr. Mark J. Schoenberg: There are many disputable points in the technic of using tuberculin, for both diagnostic and therapeutic purposes.

At the last meeting of this section someone spoke about diagnostic injections of 1 mg. of 1:1,000 and even 1:100 solutions of old tuberculin. In my experience 1:100 and 1:1,000 solutions are valueless, because they almost invariably give a positive reaction; 1:10,000, 1:100,000 and 1:1,000,000 are the most reliable solutions for detecting a positive skin reaction. But when should one regard a skin reaction as positive? Dr. Barthel told us that a red area with a diameter of 2 cm. constitutes a positive reaction. Why 2 cm.? What is one to call those with an area of 1 cm.? We know that the controls show no reaction. It seems to me that our idea as to when to call a skin reaction positive needs revision.

Another source of error in our technic of making a diagnosis is the fact that we are looking at the seat of injection twenty-four or forty-eight hours after the injection. Tell your patients who give negative reactions to the test to return daily for five or six more days, and you will occasionally discover late positive reactions. One cannot follow a hard and fast rule and say that only those patients give a positive reaction to the tuberculin skin test who show a 2 cm. red area forty-eight hours after the intradermal injection.

The intensity and time of appearance of the skin reaction depend on both the old tuberculin used—and there are surely many kinds of old tuberculin—and the general condition of the patient. The patient may give a twenty-four hour reaction today, or a forty-eight hour reaction a few weeks or months later. He

or she may respond with a mild or violent reaction, according to the phase of allergy that may be present at that particular moment.

Furthermore, I should like to make a suggestion regarding the technic of therapeutic administration of tuberculin. At the time the therapeutic injection is made subcutaneously, 1 or 2 minims should be injected intradermally. Thus one can watch the way the skin responds to the injection and gage somewhat at least one phase of the allergic state of the patient. A violent skin reaction would indicate a reduction of the strength of the solution, and vice versa.

Another important point to ask is: What happens to the tuberculin when injected under the skin? A few years ago it was found that epinephrine is only partly absorbed when injected subcutaneously and that a part of it is retained by the subcutaneous tissue. Massage of the seat of injection has an effect almost equivalent with a fresh injection. This has been tried out and verified in patients with asthma. I wonder if an injection of tuberculin may act in a similar fashion. We know that frequently an injection of tuberculin leaves behind a nodule which takes some time to resorb. Perhaps these nodules contain some tuberculin. Would the massage of such nodules give symptoms of tuberculin absorption? I have been trying out this idea, but cannot say yet whether it is of any value.

Finally, many ophthalmologists do not yet see the absurd contradiction existing between the two methods of using tuberculin, one for diagnosis, and the other for treatment. On the one hand, one is supposed to administer from 0.5 to 3 mg. or more of old tuberculin in order to make a diagnosis; on the other hand, one is warned to begin therapeutic doses of only minute values so as not to cause a flare-up of a quiescent process. How is it possible for a tuberculous focus not to flare up, when a huge diagnostic dose is given? One regards as tuberculous many processes that are not such, and in these cases tuberculin gives no focal reactions. Or are there tuberculous processes that do not react to diagnostic injections of tuberculin? If so, clinicians who base their diagnosis mainly on the clinical appearance are the nearest to the truth, though far from it.

MANAGEMENT OF GLAUCOMA. DR. WALTER R. PARKER.

This paper will be published in full in a later issue of the ARCHIVES.

DISCUSSION

DR. WILLIAM ZENTMAYER (by invitation): Dr. Parker has given a valuable paper in which he evaluates the two operations which are most frequently performed in chronic glaucoma. When one considers the thousands of operations which have been done for this disease, it is disappointing to find how few papers there are in which the ultimate results of the treatment for glaucoma have been given. Dr. Parker has typed his cases for purposes of discussion. As he says, type 1 probably does not belong to the form of glaucoma under discussion. Types 2 and 3 include those arrested by treatment and operation. It is not clear to me just how he interprets the term "arrested." Perhaps a better term would be retarded. If, however, he means literally arrested, then in my experience a comparatively small number of cases belong to either of these types. More will be found under type 4, the type that progresses in spite of all efforts.

Dr. Parker states that in the majority of his cases comparison can be made only as to the effect of the operation on the tension and the integrity of the globe, so I suppose the percentage of "good results" refers to cases in which these two conditions were favorably influenced, as well as to the smaller number of cases in which the effects on the fields could be considered "good results" as well. It

would be of interest and value had he given the results in the lesser number in which the effect as to retention of the fields as they existed at the time of the operation could be compared in the two methods of operating.

Dr. Parker has done a distinct service in giving us what he considers indications for iridectomy. No doubt by following these indications we will be rewarded by a higher percentage of successes. It will be noted in the table of iridectomies that in the additional cases the percentage of good results is 58, whereas in the previously reported cases the percentage is 72. In the table of trephining the percentage is the same for the additional cases as for the previously reported cases. I should like to know how Dr. Parker explains the much poorer showing for the iridectomies in the second series.

I have not had time to assemble the cases in my own practice for statistical presentation, not knowing until a few days ago that this would be the basis for Dr. Parker's paper, so I can only give my impressions, looking back over years of experience. No drug or operative procedure has given me results which permit me to undertake the treatment of patients with the disease with equanimity. I can record cases in which fairly satisfactory results have been obtained with most of the methods of treatment; in most of the cases, however, the immediate and the remote results have been disappointing. For teaching purposes I have tried to formulate a working basis for certain age periods and for certain classes of patients, but there are many cases which cannot be made to apply. I should consider that of the patients seen in an early stage of the disease, both in private and in hospital practice, those under 60 require early or immediate operation. Miotics with possibly some of the newer drugs may be employed with the expectation of retarding the progress of the disease for many years in patients seen in private practice who are more than 60 years of age. Miotic treatment should be used in dispensary cases only when the patient is past 65, or when the disease is so advanced that operation offers little prospect of help. When the disease is advanced in both eyes, operation should be done first on the eye in which the disease has progressed the furthest. So broad a statement leaves out of consideration many factors which must be considered in individual cases, such as very high tension, annihilation of the anterior chamber and great involvement of the central field area, which would necessitate a modification of such a working rule. When conditions and circumstances permit, I begin the treatment of primary simple glaucoma with miotics, even though operation seems inevitable. Operations are done when miotics fail to control the changes of the visual field, especially those in the central area.

Of the many operations devised for the treatment of simple chronic glaucoma, my experience so far as any considerable number of cases is concerned is limited to iridectomy and trephining. I have performed cyclodialysis many times, and iridotasis and the Lagrange operation comparatively seldom. In later years I find myself doing fewer trephinations and more iridectomies and cyclodialyses.

Recently, in conversation with the elder Gifford, he said, "No matter what operation we use for glaucoma, I suppose if we do it often enough, we will give it up." This would scarcely be called an optimistic statement, and yet, in a measure, I fear it wittily expresses my own feelings. I have gone back to a procedure I had almost given up, not that I like it more, but that I like trephining less. I temporarily abandoned iridectomy when trephining was introduced, because iridectomy frequently failed to keep down the tension, and when it did, it frequently failed to check the progress of the disease to any greater extent than miotics, and because I expected from the claims made for it that trephining would

give better results. In about one half of the cases the effect of iridectomy might be said to have been satisfactory. By that I mean that the tension was brought within nearly normal bounds, and that it preserved for a long time useful central and peripheral vision. I do not recall a case in which the condition might have been said to have been made worse by the operation, except two in the earlier days of my practice in which the technic apparently produced a cataract. However, I have not performed iridectomy when fixation was threatened, being guided by the advice of the old masters.

With trephining, however, the story is a different one, with a higher percentage of cases in which tension was permanently reduced and also a higher percentage in which along with this a greater improvement in central and peripheral vision resulted than was obtained with iridectomy, there was a considerable percentage in which both as an immediate and as a remote result the visual function of the eye was damaged. This unfortunate outcome was due in some cases to a frank iritis, in others to an insidious persistent iritis with proliferation of pigment, along with a fibrinous deposit disseminated over the anterior capsule of the lens, visible in the pupillary area and in the coloboma. In a number, subcapsular opacities, anterior and posterior, sometimes developed early; and, difficult to explain, others developed later, probably from hypotony. Finally, loss of the eye from late infection resulted in two cases. These are the reasons for my resorting to this operation less frequently than formerly.

From a slight experience with the Lagrange operation and from the results I have seen from its performance by others, I believe that this is the better filtration operation. But it is far more difficult to perform.

I have had but a limited experience with the newer drugs, epinephrine being the only one I have used to any extent, and I have not necessarily used this in any larger number of cases as the drugs are of comparatively recent introduction. Accepting the view that this agent reduced the intra-ocular tension by its action on the vessels of the choroid, which was sufficient to offset any deleterious effect it might have through its action in dilating the pupil, I early feared that conditions might exist in the vessels of the choroid which might prevent the vasoconstriction and that an acute attack of glaucoma might result from the dilated pupil. Whether the premise was correct or not, the conclusion was. One now finds in the literature many reports to this effect, so that one is warned to use miotics energetically before and after the use of dextrose epinephrine, or to use it only prior to operations. It may be safer to employ one of the drugs which has a strong miotic effect when given internally or locally.

My experience is no different from others as to the ability of epinephrine to reduce the pathologic tension, and that this action when combined with physostigmine (eserine) lasts many hours; also that it increases the efficiency of physostigmine and may in some instances renew the action of this drug after it has lost its hypotonic effect. Contrary to the observations of some, and in accord with those of Dr. Parker, I have found it of value in iritic glaucoma. It has also seemed to be a distinctly useful preliminary, by one or two hours, in operating for chronic and acute glaucoma. I have noticed in acute glaucoma that after the use of the drug in this way the cornea is clearer and then tension lower when the patients reach the operating table, and lastly, in a small group of cases in which iridectomy failed to keep the tension as low as seemed desirable, it has been of service. In two cases ephedrine in 3 per cent strength has acted well.

On the whole, while these drugs are a useful addition to our means for favorably affecting increased tension, their field I believe is restricted, and they

have neither brought us nearer our goal nor relieved us of the necessity of operating early in the course of the disease.

One of the difficult, yet most important problems in the management of simple chronic glaucoma is the management of the patient. Early they are told that they must order their lives so that their eyes are to be their first consideration. So far as possible they must be relieved of the responsibilities and stress of business; to have at least eight hours in bed at night, and to lie down for a time in the early afternoon; to have regular hours for meals; to eat food simply cooked, and never to overeat; to avoid stimulants; to use tobacco moderately (if it has been used before) and to regulate bodily functions. They are advised to consult their physician for a careful examination, especial attention being given to the cardiovascular renal system in this examination. I leave it to you how many patients have the will or are in a position to follow such a discipline.

While I consider that in many cases the size of the eyeball, especially the cornea, together with age are the determining causes of glaucoma, the question remains what are the factors in age; is it continued growth of the lens, the sclerotic effect of age on the sclera, the pectinate ligament and the other tissues about the angle of the chamber alone, or is it endocrine imbalance, arteriosclerosis and hyperpiesia and vasomotor instability? Whatever may be the answer, the patient should have a thorough physical examination, and any disorder should receive attention.

The chairman said in connection with tuberculin that one might have a good drug and get no results, because it is not used right, and I believe that probably explains the feeling about miotics. I believe that miotics, if used properly, may control the tension and fields over long periods of time, that is, if the patient is seen early in the course of the disease. Miotics must be used frequently, and their strength must be increased from time to time. The most evident signs to go by, of course, are the size of the pupil and the tension of the eye, but one will certainly be misled if one depends on these alone. After all, the field is the criterion as to what is to be done in a case of glaucoma.

Dr. Arnold Knapp: I should like to add to Dr. Parker's type 1, the type that recovers spontaneously, cases of morgagnian cataract.

In regard to type 2, especially to the observations with epinephrine, I should like to refer back to work I did some years ago in using epinephrine for diagnostic purposes. At that time we found that the tension was reduced in a certain number of cases. In a small percentage, the tension was increased, and an unpleasant attack of glaucoma characterized by a curious and unusual brownish discoloration of the cornea developed. Apparently this experience has been repeated by those who have been using a proprietary epinephrine substitute (Link's Glaucosan). The favorable results with epinephrine are particularly noticeable in cases of glaucoma which are combined with iritis. I remember being impressed with one case of increased tension and a pupil which was completely bound down, and when I gave epinephrine the pupil dilated and the tension promptly was reduced. It almost suggested the correctness of Dr. Curran's views that in glaucoma one has a sphincter which is so tightly adjusted to the capsule of the lens as to prevent the egress of the fluid from the posterior into the anterior chamber; therefore, if one dilates the pupil, one reduces the tension in these cases. We have tried a proprietary epinephrine substitute (Amin-Glaucosan) in a number of cases of acute glaucoma. Unfortunately, we have had no results. I should like to say a word or two in favor of an ergot preparation (gynergen) which seemed to us to be more successful in helping patients with glaucoma than epinephrine.

As for the selection of cases which are suited for iridectomy and for scleral resection, I think a simple rule to follow is that if the tension is reduced by miotics peripheral iridectomy is indicated. One can assume that if the tension is reduced by miotics there is no organic adhesion, and therefore a scleral resection is not necessary.

As to the form of operation one is to use in chronic glaucoma, I personally feel that the Lagrange operation is the best. At the same time I want to repeat the statement which Dr. John E. Weeks made, that one should use whichever method one has had most experience in, because with that one will have the most confidence and the greatest ease of execution.

I should like to emphasize the importance of following up cases of glaucoma. Recently I saw a patient on whom trephination had been successfully performed, and the patient's condition had been satisfactory for ten years; filtration had ceased and the tension had returned. I should like to ask Dr Parker what he does in cases in which the trephining is not successful and a repeated operation has to be done, and whether his results in these cases have been as poor as mine?

We are indebted to Dr. Parker for not only an interesting discussion of this topic, but for the admirable statistical study he has made of his material. He has given honest deductions. I think that his concluding paragraph, in which he groups his results as 60 per cent favorable, 30 per cent stationary and 10 per cent loss, is an excellent working basis to go on.

Dr. Ernst Waldstein: I was highly interested in two of the cases mentioned by Dr. Parker. The first is the case of the 17 year old girl with hereditary syphilis on whom repeated operations had to be done. From my early clinical times I remember a similar case, a woman of about 30 who had a hereditary syphilis and simple gaucoma. She had to be operated on time and again on both eyes (iridectomy, Elliot, Lagrange, Heine, posterior and anterior sclerotomy) and became totally blind just the same. Hereditary syphilis, if connected with, or responsible for, a juvenile simple glaucoma, seems to be a deleterious factor.

The other case is likewise interesting, though my experiences are different. I allude to Dr. Parker's case in which diabetes was found belatedly. In New York we see, especially among the Jewish population, many cases of diabetic diseases of the eye (retinitis, uveitis, cataract, ocular palsies) on one hand and of glaucoma simplex on the other. So far I have failed to find a single case in which glaucoma simplex and diabetes occurred in the same person. There seems, on the contrary, to be a marked antagonism between diabetes and simple glaucoma, manifestly due to the hyperacidosis of the body liquids in diabetes. However, there are some modern authors, as you know, who maintain that at least a great many of the cases of glaucoma simplex are to be ascribed to a pathologic alkalosis of the vitreous with its consequent swelling.

Dr. Walter R. Parker: I have little to add. To Dr. Zentmayer's question as to the possible explanation I can give of the failure to secure as many successful results following an iridectosis in the last series of patients as in the first, I am not certain that I can answer.

In considering what possible change in technic I have made in recent years, I am inclined to think that I have tended to make a narrower iridectomy than formerly. As far as I know this is the only change.

Dr. Knapp inquired about the management of patients that come back as failures after a trephine operation. The operation may be repeated, or massage will occasionally promote filtration. Miotics may be of benefit after operation.

Dr. Zentmayer suggested that a report of a series of early cases, including observations on the fields and complete observations, might prove helpful in obtain-

ing the operation of choice. We made observations so far as we were able to do so and could select a small series for comparison. But most of patients seen in the clinic came under observation when the disease was well advanced, or with complications, seriously impairing the vision. For this reason a surgical classification is made. In making a statistical study, it has always seemed to me better to include all the cases. When one begins to select those to be included in a report the information to be gained by a larger experience is lost.

If one were to make a statistical study of this group of patients, and secure accurate results, they might not be accurate three months later.

The suggestion offered for the selection of these cases may not be the most effective, but it has furnished a definite method of attack. I still believe that no one operative procedure is best suited for all patients with simple glaucoma. There is much to be desired.

THE INTRAVENOUS USE OF HYPERTONIC SOLUTIONS AS A ROUTINE PREOPERATIVE MEASURE IN GLAUCOMA. DR. ROBERT K. LAMBERT.

This paper will be published in full in a later issue of the ARCHIVES.

DISCUSSION

DR. JULIUS WOLFF: Dr. Lambert has covered the clinical points of interest associated with this subject, and I have nothing to add except by way of corroboration. I have observed most of these cases, and I feel certain that even though the number is small, it is sufficiently convincing to state that there is a decided uniformity in the effect of lowering the tension of the eye by this procedure. It is not really treatment for a disease, it is treatment for a symptom. We are merely treating the tension as such, and I think that that in itself can, as pointed out by Dr. Lambert, be of practical and clinical value. I convinced myself of that by questioning the patients soon after the injections in a way to get unbiased answers as to their reactions to the injection, and I received definite assurance from them that they felt a decided subjective relief from the procedure and observed an improvement in vision within from fifteen minutes to one hour after the injection was given.

Dr. Lambert has also pointed out the possible practical application of this procedure. To my knowledge it is not in practical use at present. I am not familiar with anybody who has used it, and I feel in cases in which one desires a greater reduction of tension than one can get through the use of miotics or in which operation may have to be postponed, and one must temporize, that this treatment is a decided aid to the use of the other forms of treatment preliminary to operation.

DR. J. H. GLOBUS: Dr. Lambert has covered the subject well. There are just one or two points I should like to emphasize. The first is the similarity of the effect of the injection of hypertonic fluids on the eye and on the brain. You are familiar with the fact that the aqueous humor and the cerebrospinal fluid are similar, though there is no direct connection between the chambers of the eye and the cranial cavity. Although there is no direct connection between the two fluids, it seems to be the fact that both of them are affected by similar physical conditions. Thus the injection of hypertonic solution reduces the tension within the eye in the same way as it does within the cranial cavity, and neurologists often make use of this principle to reduce tension by the introduction of hypertonic solution intravenously or in some other way. Commonly high concentration of magnesium

sulphate is administered as a retention enema for this purpose. Furthermore, headache due to increased intracranial tension is relieved in such a manner. In such cases as those described by Dr. Lambert relief was obtained before surgical steps were taken, but here just as in Dr. Lambert's cases the beneficial effect is short-lived and has to be repeated. I was impressed by the conservative stand taken by Dr. Lambert, when he pointed out that this measure is to be understood as acting not as a pharmacologic principle, but simply producing a physiologic reaction, which may be utilized for temporary relief.

Book Reviews

OCULAR SIDEROSIS. By D. D'AMICO. Rome, Annali di Ottalomologia, 1925.

This monograph presents a complete study of siderosis as it affects the eyes. The author finds that previous publications on the subject have been incomplete, and that the results reported from the use of certain of the chemical tests for iron are open to numerous objections. D'Amico first tested a number of fresh human eyes, using all of the ordinary tests for iron. When no acids were used in the reaction, only the pigment epithelium of the pars ciliaris retinae showed an iron reaction. In eyes treated with various acids a reaction was given in the corneal and conjunctival epithelium, the ciliary epithelium and the nuclear layers of the retina. The author believes that a definite distinction between organic and inorganic forms of iron cannot be made on the basis of these reactions. He distinguished only between iron in its ionized form which gives the reaction without the use of acids and in its nonionized form, giving a reaction only after the use of acid or other hydrolyzing agents.

The effect of all the ordinary fixatives on the iron reaction was studied. With the use of most of the fixatives, some diffusion of iron through the tissues occurred although this varied markedly with the different fixatives and was practically absent with one, pyridine. A review of previously reported cases of siderosis shows that the globes in most cases have been kept for considerable periods in various fixatives, in some as long as twelve years so that the results of iron reactions reported in these cases must be considered, according to the author, as artefact. Some fixatives, such as Zenker's solution, themselves cause a deposit of pigment in the tissues which may resemble iron. The pigment which could be considered due to postmortem diffusion gave a rapid reaction to all the iron agents and was easily removed from the tissues by weak acids so that it could be distinguished from true pathologic deposits of iron. In globes with true siderosis the pigment around the foreign body shows iron in unstable form, as shown by prompt reaction to all the common reagents, while pigment at some distance from the foreign body existed in more stable form, reacting only with certain reagents at higher temperature. A great deal has been written about the differentiation between hemosiderin which gives a reaction for iron and hematoidin which does not react with the ordinary reagents. By using various hydrolyzing agents and high temperatures, the author was able to demonstrate iron in all deposits of blood in the tissues. He concludes that a sharp distinction between hemosiderin and hematoidin therefore is impossible.

Twenty-eight globes containing steel and eleven containing blood deposits were examined. Experimental siderosis was produced by leaving fragments of iron in the vitreous of rabbits' eyes, operative hemorrhage being avoided as much as possible. These eyes were compared with eyes into which blood had been introduced. The eyes were sectioned at various periods up to two months, while in the clinical cases

the foreign bodies had remained in the eye for periods from a few hours to eight years. From the author's results, he concludes that a number of changes previously described as due to siderosis should really be attributed to trauma and resulting inflammation. The presence of iron granules in the various parts of the eye is described. The presence of iron was tolerated with very little reaction by most of the tissues. The lens showed degeneration of its epithelium with subcapsular opacities. The retina in proximity to the foreign body showed a dense infiltration with iron granules especially in the nerve fiber layer and some degeneration of the layer of rods and cones. This was more marked in the periphery of the retina, hence accounting for the field changes described in eyes with siderosis. Photomicrographs showing the changes described and a complete bibliography are included.

SANFORD R. GIFFORD.

THE BOOK OF THE TEN TREATISES ON THE EYE ASCRIBED TO HUNAIN IBN IS-HAQ (809-877 A. D.). By MAX MEYERHOFF, M.D., PhD. Pp. 227. Cairo, Egypt: Government Press, 1928.

The deluge of historical medical essays and medical histories which has been swamping both professional and layman continues. The recent effort by Max Meyerhof in Cairo should find favor with the ophthalmologist. It is a thoroughly scholarly and scientific attempt to depict ophthalmologic conditions in the ninth century when Hunain Ibn Is-Haq wrote his treatises on the eye. According to Meyerhof, these treatises constitute the first systematic textbook on ophthalmology known in medical history.

There are two large divisions in Meyerhof's book. These are the introduction and the translation. Both sections merit attention. The author acknowledges, at the outset, his indebtedness to Hirschberg, whose "Geschichte der Augenheilkunde" gave him many clues to his problem. There were several missing links in Hirschberg's work and the author wished to complete the former's picture. With this object in view Meyerhof examined scores of original manuscripts, many of which he names and describes in the introduction. Among these is to be found Hunain's treatises on the eye. Meyerhof realized that Hunain's treatises gave the most complete view of ophthalmology that had ever been written up to the latter's period. He therefore decided to devote his book to these treatises, to the author Hunain, his life, his works and an actual translation of the most authentic manuscripts containing the discourses which were obtainable.

Meyerhof has no definite proof that Hunain, an Arabian Court physician and distinguished practitioner, of the ninth century, has written the treatises. There is no proof, however, to the contrary, and his supposition that Hunain is the compiler of the treatises meets with unanimous support. It seems that Hunain's most important contribution to his period is not his medical knowledge but rather his translations, particularly of Galen's works, into Syriac and Arabic. At this task he was admirably adept and brought to the courts numberless masterpieces from the earlier Greeks. His ability as a synthesizer of extracts taken from his own translations caused him to write the "Ten Discourses or Treatises on the Eye." Meyerhof is definite in his contentions that these discourses are for the main not original but are taken from Galen,

Hippocrates and other Greek philosophers. In spite of this, Hunain is deserving of much praise because his discourses give the most complete picture of ophthalmology that had been composed up to his time.

In 148 pages are to be found the ten treatises. It would be a prodigious task for such a report to discuss all the ideas that are found therein. The whole study of ophthalmology is involved. There are two things, however, which can be done. First, to present a few interesting conjectures which Hunain supported with great avidity and, secondly, to describe the contents of the discourses. The completion of the task lies in the hands of the reader and will terminate when the book itself is read. Meyerhof believes that the reading is not a pleasant task, even in English. While this is somewhat true, it will be found that Hunain writes in an interesting and naive style. The ophthalmologist, physiologist, pharmacologist and anatomist will find many amusing lines. That paternal attitude which must of necessity be assumed when dealing with such an obviously ancient and elementary treatment will be the cause of an evening's pleasant and educational entertainment.

Hunain was convinced that the lens was in the center of the eye and was nourished by the humours which bore the visual spirit. This spirit was brought from the brain by the hollow optic nerves. To him sensory nerves were soft and hollow; motor, hard and solid. He recognized the olfactory lobes but nevertheless called the optic nerves the first set arising from the brain. In general he always makes an effort to reconcile an anatomic structure with his philosophic trend of mind. The book therefore contains many interesting speculations concerning the existence and physiology of the eye.

On the other hand, the author shows a knowledge of the eye which is surprisingly modern. He argues for the existence of decussation in the chiasma; he recognized the visual reflex, the light reflex and the accommodation reflex. Besides this, his descriptions of many pathologic conditions are good, even if they are short. The long discussions are awarded to anatomy, physiology, nosology and pharmacology. This of course was in accordance with his philosophic and speculative habits.

As for the treatises themselves, they are devoted to the following subjects, which have been listed according to his classification: The first treatise concerns the anatomy of the eye including the then modern diagram of its structure. In addition to the six muscles, a retractor buibi is added. This is an unusual feature and is probably adopted from the animals studied; although not noticeable in man, such a vestigial structure has been described in the literature. The second treatise deals with the descriptions of the brain following the plan laid down by Galen. The third treatise is very long and deals with the optic nerves, the hypothetic visual spirit and the vision itself. The fourth treatise gives a skilfully made extract from various books of Galen composing all his ideas on nosology, etiology and symptomatology.

The fifth treatise has to do with the causes of diseases of the eye. He mentions dislocation of the lens, disturbances of the brain and diseases of the optic nerve as the main causes of diseases of the eye. Opacities and injuries of the cornea and diseases of the uvea are also recognized as causes. Hunain realized that normal contraction of the pupil aided vision while pathologic contractions interfered with vision. He describes traumatic as well as senile cataract, but he attributes their presence to a

translucent condition of the aqueous. Vitreous opacities are caused by changes in color in the aqueous. Pterygium, trachoma, paralysis and strabismus are also discussed among the numerous other causes of diseases of the eye.

The sixth treatise is one of the most interesting, since it discusses the symptoms and diseases of the conjunctiva, lid, lacrimal ducts, cornea and cataract. The descriptions show a rather good appreciation of many pathologic conditions. A few of the conditions described are herewith included: subconjunctival hemorrhage; pannus with disturbance of the pupillary area; trachoma with its accompanying complications; edema due to injuries of the lids; conjunctivitis and orbital abscesses; itching is mentioned, but probably vernal catarrh is meant. As for the external diseases of the lid, dermoids, blepharitis, chalazion, lethiasis of the conjunctiva, symblepharon, lagophthalmos, ectropion, trichiasis, hordeolum, lacrimal diseases, phlyctenular, hypopyon, staphyloma of the cornea, intercalary staphyloma and phthisis bulbi are described. Cataract (with its ten shades) was familiar to him, too.

The seventh treatise deals with the faculties of the simple remedies. A number of remedies are mentioned the physiologic actions of which are determined by their action on the tongue. This treatise follows entirely Books IV and V of Galen's "De Simpl, Medicament."

The eighth treatise deals with the simple remedies for the eye. These come from three sources, vegetable, mineral and animal. There are fifty-two remedies suggested, most of which are obsolete. Skilful extracts from Galen again abound.

The ninth treatise contains the treatment for diseases of the eye but without order and several times interrupted by theoretical expositions on general diseases. Swellings and special diseases of the eye compose this book. The former condition was due to an overflow of body fluids or of air. Discoloration of the eye was caused by gall. Hunain was blissfully ignorant of the fact that such a condition could be due to the decomposition of the blood. The cure of swellings was effected by incisions and drainage followed by local applications. Ophthalmia was treated by astringents, compresses and bandages. Galen evidently has helped Hunain again.

The tenth treatise tells of compound remedies suitable for diseases of the eye. Most of the recipes are named after men like Nilus, Paccius, Galio and Paul. The compounds themselves breathe of medievalism and a world full of portents and spirits. The treatment for superfluous hairs, for instance, calls for the use of feces of mice; another for headless flies; another for lice found on dogs. Such ancient and superstitious prescriptions are found on the same page with a most extraordinary discussion of treatments to be applied to wounds of the lid.

The mention of surgery is in general meager. No definite plans are laid down until cataract is mentioned. Here couching is advised. A great deal of stress is placed on the gentle handling of the eye during operation, an art so greatly lacking in modern ophthalmic surgeons. Hunain did not approve of the operation because of its grave prognosis. He shows mature judgment here.

It will be noted that the etiology of diseases are found in one treatise, the semiology in another and the treatment in still another. This method characterized all medical writing up to Hunain's time. In conclusion,

the book contains an Arabic version of the English side, or perhaps the book is Arabian with an English supplement. An excellent glossary of Arabian and Greek medical terms is also included. There should be little doubt that Meyerhof has done an excellent piece of work in his book. One is justified in praising him highly for his painstaking and scholarly efforts in organizing and presenting his material. The reading of the introduction may be a bit confusing with its numerous parenthetical Arabic inscriptions. There is a pleasant vista ahead for the reader who makes an attempt to overcome these superficial distractions.

ISADORE GOLDSTEIN.

Directory of Ophthalmologic and Otolaryngologic Societies *

FOREIGN

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. A. B. Cridland, Salisbury House, Chapel Ash, Wolverhampton. England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford, England. Time: July 4-5, 1929.

INTERNATIONAL

INTERNATIONAL CONGRESS OF OPHTHALMOLOGY

President: Dr. E. Treacher Collins, 17 Queen Anne St., London, England.
Secretary: Dr. E. Mark, Academisch Zickenhuis, Leyden, The Netherlands.
Place: Amsterdam, The Netherlands. Time: Sept. 5-13, 1929.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. William C. Finnoff, Imperial Bldg., Denver.
Place: Portland, Ore. Time: July 10-12, 1929.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Harris P. Mosher, 828 Beacon St., Boston.
President-Elect: Dr. William H. Wilder, 122 S. Michigan Ave., Chicago.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: Atlantic City, N. J. Time: Oct. 21-25, 1929.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter R. Parker, David Whitney Bldg., Detroit.
Secretary: Dr. Emory Hill, 501 E. Franklin St., Richmond, Va.
Place: Hot Springs, Va. Time: June 10-12, 1929.

LOCAL

LOS ANGELES COUNTY MEDICAL SOCIETY, SECTION OI· OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Harold S. Muckleston, 6422 Hollywood Blvd., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 1208 Roosevelt Bldg., Los Angeles

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Dr. Walter A. Wells, 1606 20th St. N. W., Washington.
Secretary: Dr. J. N. Greear, Jr., 1740 M St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

ATLANTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. F. McDuffie, 45 Edgewood Ave., Atlanta, Ga.
Secretary: Dr. Leon E. Brawner, 157 Forrest Ave. N. E., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. N. E. Time: 8 p. m., last Thursday of each month.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Lafayette Page, Hume-Mansur Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. M. Earle Brown, Maison Blanche, New Orleans.
Secretary-Treasurer: Dr. W. A. Wagner, Pere Marquette Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., third Thursday of each month from September to June.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Leon J. Goldbach, 1012 N. Charles St., Baltimore.
Secretary: Dr. Angus Lloyd MacLean, Johns Hopkins Hospital, Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Holbrook Lowell, 82 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. E. B. Dunphy, 520 Commonwealth Ave., Boston.
Place: Massachusetts Eye and Eye Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
Secretary: Parker Heath, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. R. Forgrave, Logan Bldg., St. Joseph, Mo.
Secretary: Dr. A. E. Eubank, Argyle Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. William H. Luedde, Metropolitan Bldg., St. Louis.
Secretary: Dr. Leo L. Mayer, Carleton Bldg., St. Louis.
Place: St. Louis or Washington University Cafeteria.
Time: 6:30 p. m., fourth Friday of each month from October to April, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. Charles M. Swab, Medical Arts Bldg., Omaha.
Secretary: Dr. J. C. Davis, 1615 Howard St., Omaha.
Place: Medical Arts Tea Room. Time: 5:15 and 7:00 p. m. Third Wednesday of each month from October to May.

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Lee W. Hughes, 1019 Broad St., Newark.
Secretary: Dr. Earle LeRoy Wood, 31 Lincoln Park, Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Robert M. Rogers, 680 St. John's Pl., Brooklyn.
Secretary: Dr. William F. C. Steinbugler, 515 Ocean Ave., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday of February, April, May, October and December.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. M. S. Lord, 148 Barrett St., Schenectady.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. E. E. Blaauw, 190 Ashland Ave., Buffalo.
Secretary-Treasurer: Dr. A. F. Luhr, Medical Arts Bldg., Buffalo.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. B. Samuels, 57 W. 57th St., New York.
Secretary: Dr. T. B. Johnson, 30 W. 59th St., New York.
Time: 8:30 p. m., third Monday of every month.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Cecil B. Hert, 29 N. Goodman St., Rochester, N. Y.
Place: Rochester Medical Assn., 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George M. Constans, Bismarck.
Secretary-Treasurer: Dr. F. L. Wicks, Valley City.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Myron Metzenbaum, Rose Bldg., Cleveland.
Secretary: Dr. A. D. Ruedemans, Euclid and E. 93d St., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Joseph L. McCool, 909 Stevens Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

THE PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

THE PITTSBURGH SLIT-LAMP SOCIETY

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of month, except June, July, August and September.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Robert R. Hampton, Boston Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.
Place: Salt Lake City: Time: July 1 and 2, 1929.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. C. E. G. Shannon, 17th and Walnut Sts., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. William Thornwall Davis, 927 Farragut Sq., Washington, D. C.
Secretary: Dr. Fletcher D. Woodward, Box 162, University, Va.
Place: Miami, Fla. Time: Nov. 20-22, 1929.

THE MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John G. McLaurin, Medical Arts Bldg., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, Medical Arts Bldg., Dallas, Texas.
Recording Secretary: Dr. L. M. Sellers, Medical Arts Bldg., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. P. Schenck, Medical Arts Bldg., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Needham, Fort Worth National Bank Bldg., Fort Worth, Texas.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

HOUSTON ACADEMY OF MEDICINE, EYE EAR, NOSE AND THROAT SECTION

President: Dr. John H. Foster, 1300 Walker Ave., Houston, Texas.
Secretary: Dr. Edward W. Griffey, Houston Clinic, Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

THE SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. F. H. Roseborough, 302 Moore Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Will Otto Bell, Medical-Dental Bldg., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, Medical-Dental Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Herschel Ezell, Doctor's Bldg., Nashville, Tenn.
Secretary-Treasurer: Dr. W. W. Wilkerson, Jr., Bennie-Dillon Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. H. B. Stone, Roanoke.
Secretary-Treasurer: Dr. Fletcher D. Woodward, Box 162, University.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. O. M. Rott, Paulsen Bldg., Spokane Wash.
Secretary: Dr. C. A. Veasey, Jr., Spokane, Wash.

THE MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. L. P. Allen, 145½ Main St., Oshkosh, Wis.
Secretary-Treasurer: Dr. Edward R. Ryan, 425 E. Water St., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.